Mission Restoration Project

Hydrologic/Aquatic Resources Report

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Methow Valley and Tonasket Ranger Districts
Okanogan-Wenatchee National Forest

for:
Methow Valley Ranger District
Okanogan-Wenatchee National Forest

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Contents

Regulatory Framework

Land and Resource Management Plan

The Okanogan National Forest Land and Resource Management Plan (Forest Plan)(USDA-FS 1989) provides standards and guidelines for aquatic, riparian, and hydrologic resources within the Mission Restoration Project Area. The Record of Decision and Environmental Impact Statement for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl (Northwest Forest Plan, USDA and USDI 1994a) amended this Forest Plan in 1994.

The general desired condition (DC) for aquatic habitat is for fish rearing, spawning, and migration habitat to be in an improved state; riparian areas will continue to display riparian ecosystem values; aquatic habitat to support threatened and endangered species will be protected in accordance with recovery plans; and water yield and quality will be substantially the same (USDA Forest Service 1989a page 4-5). Fish habitat management objectives that apply to this project are: to maintain and improve fish habitat capability, and integrate fish and riparian habitat management into other multiple use activities. Pertinent goals to the proposed activity under the Forest Plan are for fish habitat to be managed to maintain or enhance its biological, chemical, and physical qualities. The structural and functional properties of aquatic systems will be managed to promote bank and channel stability and riparian areas will be managed to provide a continuing supply of large wood for fish habitat (USDA Forest Service 1989 page 4-2).

A range of standards are included in the Forest Plan (USDA Forest Service 1989, as amended) that is applicable to the management of riparian and aquatic resources. Forest Plan standards and guidelines require maintenance or enhancement of riparian and aquatic habitat parameters that affect fish and other aquatic life. These parameters include fine sediment, pool habitat, large woody debris, riparian vegetation, and provision of fish (aquatic) passage at road crossings.

Under the Northwest Forest Plan, riparian standards and guidelines apply to riparian ecosystems Forest-wide, but as a minimum they shall be applied to areas within 100 feet slope distance either side of intermittent streams, wetlands less than one acre, and unstable areas, 150 feet slope distance of perennial non-fish bearing streams or wetlands greater than one acre, and 300 feet slope distance of fish bearing streams, lakes or natural ponds.

Okanogan Forest Plan

Standards and Guidelines that apply to this project include:

Riparian (USDA Forest Service 1989a pg 4-31):

2-14 In streamside management units class IV streams (intermittent streams), management activities shall not deteriorate water quality below current Washington State water quality standards for downstream SMU class I, II, and 111 streams. Water quality changes in class IV streams may involve some short-term temperature and turbidity increases.

Fisheries (USDA Forest Service 1989a pg 4-30-32):

3-1 Maintain or enhance biological, chemical, and physical qualities of forest fish habitats.

3-2 Rehabilitate fish habitats where past management activities have adversely affected their ability to support fish populations. Those fish habitats identified as having impacts from management activities shall be managed to show an upward trend with at least a 5 percent increase in condition per year until objectives for the habitat are met.

3-3 Sediment in streams shall be maintained at levels low enough to support good reproductive success of fish populations as well as adequate instream food production by indigenous aquatic communities to support those populations. Fines measured as 1.00 mm or less in spawning areas (pool tail outs and glides) should be maintained at less than 20% as the area weighted average.

3-5 Provide an average ofleast 20 pieces of large wood per 1,000 lineal feet of stream channel on fish bearing streams to provide for aquatic needs.

- Class I & II streams (see definition below) – Minimum length 35 feet and average diameter of 12 inches with at least 20 percent over 20 inches.
- Class III streams – Diameters the same as above but minimum length is based on one and a half times the channel width.

3-6 Manage riparian vegetation to provide sufficient trees near the stream channel to act as a source of large woody debris for future instream fish habitat needs.

3-7 Channel disturbing activities should be conducted at minimum flow, or outside of critical spawning and incubation periods.

3-8 Structures, such as bridges, culverts, and dams, placed in fish bearing streams shall be designed to allow upstream and downstream passage of both adult and juvenile fish.

During construction utilize special installations (i.e. sediment traps, settling ponds, coffer dams, etc) to keep sediment from reaching the stream.

Water (USDA Forest Service 1989a pg 4-45-46):

13-2 All State of Washington (Washington Administrate Code, Chapters 173-201 and 202)through planning, application, and monitoring of Best Management Practices (BMPs) in conformance with the Clean Water Act, regulations, and Federal guidance issued.

13-3 In cooperation with Washington State, the Forest shall use the following process;

- Select and design BMPs based on site-specific conditions, technical, economic, and institutional feasibility, and the water quality standards for those waters potentially impacted.
- Implement and enforce BMPs.
- Monitor to ensure that practices are correctly applied as designed.
- Monitor to determine theeffeteness of practices in meeting design expectationsand in attaining water quality standards.
- Evaluate monitoring results and mitigate where necessary to minimize impactsfrom activities where BMPs do not perform as expected.
- Adjust BMP design standards and application when It is found that beneficialuses are not being protected and water quality standards are not being achievedto the desired level. Evaluate the appropriateness of water qualitycriteria forreasonably assuring protection of beneficial uses. Consider recommending adjustmentof water quality standards.

Northwest Forest Plan

The Northwest Forest Plan (NWFP) amended the Forest Plan in 1994 (USDA and USDI 1994). The NWFP includes an Aquatic Conservation Strategy (ACS) with four components: RRs, Key Watersheds, Watershed Analysis, and Watershed Restoration. In addition, the ACS includes nine objectives to guide management of National Forest System lands at the watershed scale that focus on maintaining and/or improving conditions and processes associated with streams and adjacent riparian areas. Standards and Guidelines in the NWFP for RRs of particular relevance to the project include:

Timber Management
TM-1. Prohibit timber harvest, including fuelwood cutting, in RRs, except asdescribed below. RR acres shall not be included in calculations of the timber base.

c. Apply silvicultural practices for RRs to control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain AquaticConservation Strategy objectives.

Roads Management
RF-2. For each existing or planned road, meet Aquatic Conservation Strategy objectives by:

a. Minimizing road and landing locations in RRs.
b. Preparing road design criteria, elements, and standards that govern construction and reconstruction.
c. Minimizing disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flow.
d. Avoiding wetlands entirely when constructing new roads.

RF-4. New culverts, bridges and other stream crossings shall be constructed, and existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associated bedload and debris.

RF-6. Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams.

Fire/Fuels Management

FM-1. Design fuel treatment strategies, practices, and activities to meet Aquatic Conservation Strategy objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuels management activities could be damaging to long-term ecosystem function.

FM-4. Design prescribed burn projects and prescriptions to contribute to attainment of Aquatic Conservation Strategy objectives.

Aquatic Conservation Strategy

The ACS has four components: RRs, Key Watersheds, Watershed Analysis, and Watershed Restoration. ACS objectives (USDA and USDI 1994b :B-11) most pertinent to the desired conditions and riparian management objectives within the project area, and that were tracked through the analysis, are maintain and restore water quality, sediment regime, instream flows, and species composition and diversity of plant communities.

How the four components relate to the project and project area is explained below:

1. **RRs**: Under the ACS, RRs are used to maintain and restore riparian structures and functions of intermittent streams, confer benefits to riparian-dependent and associated species other than fish, enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas, improve travel and dispersal corridors for many terrestrial animals and plants, and provide for greater connectivity of the watershed. The RRs will also serve as connectivity corridors among the Late-Successional Reserves. Prescribed widths for RRs are as follows necessary to meet Aquatic Conservation Strategy objectives for different waterbodies are established based on ecologic and geomorphic factors.

   RRs, as described in detail in the Aquatic Conservation Strategy, are specified for five categories of streams or water bodies as follows:

   - Fish-bearing streams - RRs consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.

   - Permanently flowing non-fish-bearing streams - RRs consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest.

- Constructed ponds and reservoirs, and wetlands greater than 1 acre – RRs consist of the body of water or wetland and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than 1 acre or the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.

- Lakes and natural ponds - RRs consist of the body of water and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance, whichever is greatest.

- Seasonally flowing or intermittent streams, wetlands less than 1 acre, and unstable and potentially unstable areas - This category applies to features with high variability in size and site-specific characteristics. At a minimum, the RRs must include:

  The extent of unstable and potentially unstable areas (including earthflows),

  The stream channel and extend to the top of the inner gorge,

  The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, and

  Extension from the edges of the stream channel to a distance equal to the height of one site- potential tree, or 100 feet slope distance, whichever is greatest.

A site-potential tree height is the average maximum height of the tallest dominant trees (200 years or older) for a given site class.

Intermittent streams are defined as any nonpermanent flowing drainage feature having a definable channel and evidence of annual scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two physical criteria.

2. **Key Watersheds**: Key Watersheds serve as refugia that are crucial for maintaining and recovering habitat for at-risk fish species and stocks. These refugia include areas of high quality habitat as well as areas of degraded habitat. The Buttermilk Creek portion of project area lies within the Twisp River 10th field watershed Tier 1 Key Watershed.

3. **Watershed Analysis**: Watershed analysis is a systematic procedure for evaluating the geomorphic and ecologic processes operating in a specific watershed. The Forest Service completed a watershed analysis for the entire Twisp Watershed in 1995 (USDA 1995), which includes the Buttermilk Creek drainage. The Libby Creek drainage had a specific watershed analysis completed in 1995 (USDA 1995) and it was reviewed again in 1999 with the Lower Methow River Watershed Analysis (USDA 1999).

4. **Watershed Restoration**: Watershed restoration is a comprehensive, long-term program to restore fish habitat, riparian habitat and water quality. Watershed restoration activities on the

Methow Valley Ranger District are guided by the Region 6 Aquatic Restoration Strategy and the Okanogan-Wenatchee's Whole Watershed Restoration Procedure. These strategies include identifying priority watersheds for restoration, identifying degraded habitat indicators, and developing treatment actions that move these indicators toward desired conditions. A key part of our strategy is to coordinate the design/implementation of restoration projects with other agencies and interest groups, and increasing the availability of resources such as partnerships to successfully implement the strategy.

The Endangered Species Act, Forest Plan direction, and the Magnuson-Stevens Fishery Conservation and Management Act require that consultation be completed with respect to effects of proposed activities on Endangered, Threatened, Sensitive, and Management Indicator Species, Critical Habitat, and Essential Fish Habitat. The species and habitat of concern in the Mission Restoration project are described later in this section. Consultation on effects to Endangered Species Act (ESA) listed species was conducted with the required regulatory agencies (U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS)) prior to issuance of the EA and Decision Notice for the project.

Federal Law

The principle federal law pertaining to hydrology impacts is the Clean Water Act (CWA), as represented collectively by The Water Quality Act of 1987 (PL100-4), The Clean Water Act of 1977 (PL95-217) and the Federal Water Pollution Control Act Amendments of 1972. The CWA characterizes water pollution from forest land-use activities as "non-point-source pollution", and describes the use of best management practices (BMPs) as the most effective means of preventing and controlling non-point-source pollution. It also establishes state roles in water-resource classification, development of water quality standards, and identification of waters that are unlikely to comply with those standards.

Executive Orders

Executive Order (EO) 11990 (protection of wetlands) requires federal agencies to

> *"minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands..."*

EO 11988 (protection of floodplains) requires federal agencies to

> *"restore and preserve the natural and beneficial values served by floodplains…"* and to *"evaluate the potential effects of any actions it may take in a floodplain…."*

State and Local Law

Washington State water quality standards that are applicable to this project are Washington Administrative Code, Title 173, (WAC 173-201A-600).

Water Quality Standards

The State of Washington has designated the streams draining National Forest System Lands to the Columbia, Okanogan, and Methow River watershed as Antidegradation Segments. This indicates that the existing water quality is better than the established standards for the designated beneficial uses. Water quality is required by state regulation to be maintained at this level. State antidegradation rules require that water quality not be lowered to any measurable extent (e.g. not more than 5 Nephelometric Turbidity Units [NTU] for turbidity, background under 50 NTU) where feasible methods exist to prevent or significantly reduce that effect. Even where measurable lowering of water quality is being prevented, antidegradation rules require that no activity cause or contribute to a violation of the numeric turbidity criteria or harm the existing or designated uses established in the state standards for the specific water bodies.

Classification and designation of water quality uses and standards for the area encompassed by the project area is extracted from the State of Washington “Use designations – Fresh Waters” (WAC173-201-600) (Washington 2011). Waters within the analysis area are protected for the uses of salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values. Since the waters are on National Forest System lands, they are additionally protected for the designated uses of: “Core summer salmonid habitat”; and “extraordinary primary contact recreation”.

These designations describe the Washington State Department of Ecology (DOE) criteria for water temperature, turbidity, and fecal coliform. There are ESA-listed salmonids in the analysis area that require cool water with low sediment loads.

Other Guidance or Recommendations

The Forest Service Manual (FSM) 2500

- Chapter 2530 Watershed Management directive establishes the framework for sustaining water quality and hydrologic function while providing goods and services outlined in forest and grassland land management plans.
- Chapter 2550 Soil Management directive establishes the framework for sustaining soil quality and hydrologic function while providing goods and services outlined in forest and grassland land management plans.

Memorandum of Understanding (MOU) between the Washington State Department of Fish and Wildlife and USDA Forest Service Pacific Northwest Region (2012). This MOU provides guidance how to implement projects that occur within streams and wetlands.

Affected Environment

The proposed project is located within the Twisp River and Lower Methow River watersheds. Proposed management activities extend across two 12th field watersheds: Buttermilk Creek (Twisp) and Libby Creek (Lower Methow) (Figure 1). Project effects are analyzed on streams in these sub-watersheds. The project area contains habitat for fish species listed under the ESA, Regional Forester’s Sensitive Species, Management Indicator Species (MIS), and species for which Essential Fish Habitat (EFH) has been designated under the Magnuson-Stevens Fishery Conservation and Management Act.

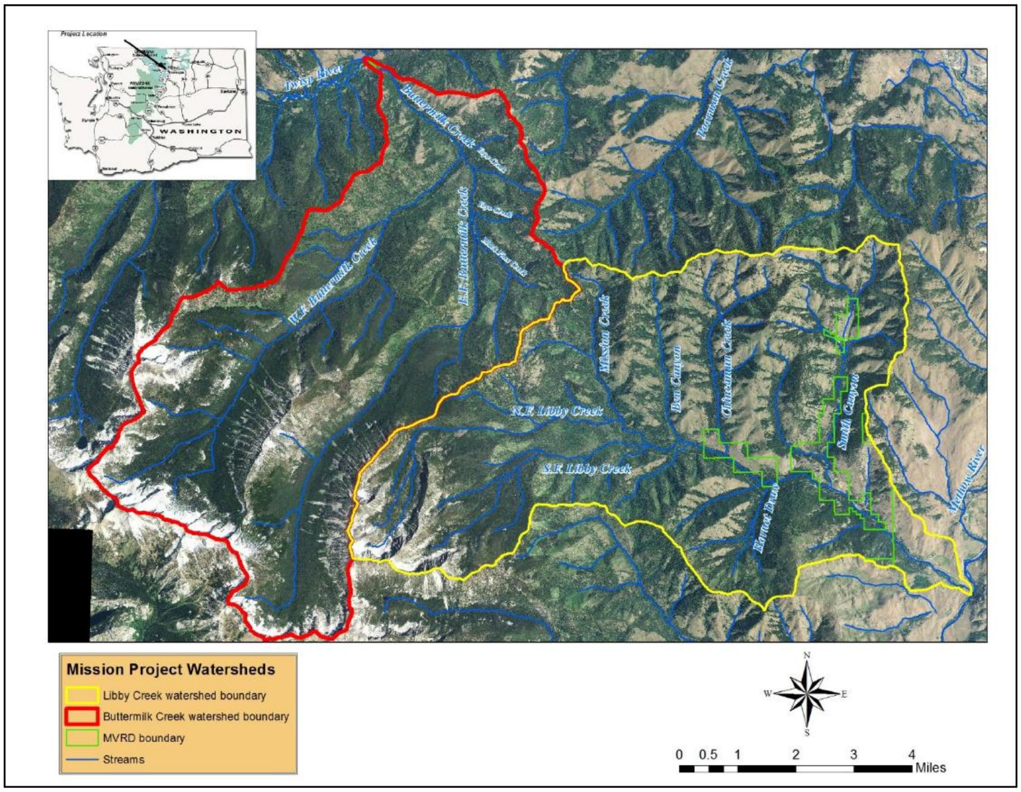

Figure 1. Mission Project area sub-watersheds.

Considered but Not Analyzed In Detail

The following indicators or identified issues were considered, but were dropped from further analysis as listed in the rationale in Figure 2.

Figure 2.Resources Considered But Not Analyzed in Detail

Resource/Identified Issue	Rationale for Dismissing from Further Analysis
Chemical contaminants	Use of equipment or fueling of equipment in proximity to stream can add toxins to waterways. This indicator is mitigated to negligible levels due to implementation of design criteria that keep chemical contaminants outside areas where they could be delivered to streams in measurable volumes or contained by BMPs.
Floodplain Habitat	Thereis little floodplain in the project area due the higher gradient channels. Stream channels are mostly Rosgen (1994) type A channels with a few type B reaches. These channel types typically have little or no floodplain. This project would not change watershed conditions that would alter the small amount of floodplain in the project area. Therefore, this resource indicator does not apply to this project.

Water Quantity (Peak flow)	This project will not impact water yield in any measurable way from vegetation cover removal. Research from 95 watershed experiments conducted in the United States forests show that on average, annual runoff increased only ~0.1 inches for each 1% of watershed area harvested (Stednick 2006). This issue will not be carried forward since there are no clear cut harvest areas proposed and regeneration harvests (selective seed tree) proposed are equivalent to ~1% of the watershed in this project. Project Design Criteria require that no more than 20% of any watershed area be treated annually (Stednick 2010), Beche et al. 2005). Riparian Harvest, beaver introduction and increases in drainage network from roads will be discussed as it pertains to water yield.
Water Quality (temperature)	This project will not have a measurable effect upon temperature at the reach or HUC scale. Direct solar radiation is the largest driver for temperature alteration and the removal of a few overstory trees along fish streams will not decrease shading or increase temperature. Thinning and prescribed fire ignitions are located outside of RRs.
Livestock Grazing	This is not a resource element, but is an impact on the landscape. The recent Libby, Little Bridge, Newby, and Poorman Allotment Management Plan Revision (USDA 2011) analyzed impacts from livestock grazing in the project area. There is a comprehensive monitoring plan to ensure critical resource values are protected. Mechanisms in this plan provide for making changes to livestock management as needed. Livestock grazing is outside the scope of the Mission Restoration Project.
Private Irrigation Withdrawals	This is discussed as it pertains to cumulative effects and existing condition. Water rights are a legal issue and this project will not change any existing rights or withdrawals.

Resource Indicators and Measures

The resource elements, indicators, and measures used to analyze and compare potential effects of the Mission Restoration on hydrologic and aquatic resources are shown in Figure3. Indicators and measures address the purpose and need and key internal issues raised during project planning. A description of how each measure was calculated is included in the Methodology section of this report.

Figure 3.Resource indicators and measures for measuring and comparing potential effects between alternative. Don't need to have multiple times,

Resource Element	Indicator	Measure	Key Issue	Source
Water Quality (Sediment)	• Road density • Road drainage network increase • Riparian road density • Road-stream crossingdensity • Groundcover	• Number of Catchment Rankings Lowered • Acres of bare soil	P&N #1	NWFP S&G 1994; UCSRP 2007; WCF 2010
Water Quantity (baseflow)	• Beaver habitat	• Number of beaver release sites	P&N #1	NWFP S&G 1994; UCSRP 2007; WCF

				2010
Aquatic Habitat	• Stream channel complexity • Fish distribution	• Miles of stream restored with course woody debris • Miles of stream accessible to fish • Number of aquatic organism passage pipes installed	P&N #1	NWFP S&G 1994; UCSRP 2007; WCF 2010

Methodology

Scale of Analysis and Watershed Hierarchy

The 25,500-acre Buttermilk and 23,500-acre Libby Creek sub-watersheds are within the Twisp River and Lower Methow River watersheds, within the Methow River sub-basin. The watershed hierarchy of the project area sub-watershedsare shown in Figure4.

Figure 4. Watershed hierarchy of the Mission Project area.

Basin	Sub-basin	Watershed	Sub-watershed
Upper Columbia 170200	Methow River 17020008	Twisp River 1702000805 Lower Methow River 1702000807	Buttermilk Creek 170200080506 Libby Creek170200080701

The hydrologic and aquatic analysis area for the Mission Restoration Project is the Buttermilk and Libby Creek sub-watersheds. Direct, indirect, and cumulative effects are analyzed at the scale of all lands in these sub-watersheds. The temporal scale for effects analysis is 30 years--the time it is estimated to take for morphological improvements in stream channel variables from upland treatments to be measureable.

Hydrologic and Aquatic Limiting Factors

To set the focus for restoration goals in the development of the Mission Restoration Project, the hydrologist and fish biologist identified limiting factors for watershed condition and aquatic habitat. Information on limiting factors for the project area was gathered from several sources including the Upper Columbia Biological Strategy (2014) and the NMFS approved UCRSSRP (2007), and the Salmon, Steelhead, and Bull Trout Habitat Limiting Factors report for the Methow Valley (Andonaegui 2000). Additionally, theOkanogan-Wenatchee Watershed Condition Framework update (USDA 2011), Level II streams surveys (USDA 2010 & 2011) and field observations within the project area helped identify the project area limiting factors. The limiting factors include:

- Water Quality - riparian roads and livestock grazing are chronic sources of erosion and sediment delivery. Episodic road failures contribute large volumes of sediment during storm events

- Water Quantity – summer and fall base flows are reduced from water withdrawals from private irrigation ditches and water transmission lines
- Stream Channel Complexity – past riparian harvest has reduced natural wood recruitment. Instream coarse woody debris levels are low in multiple fish streams.
- Fish Access – full or partial barrier culverts limit fish passage and prevent access to suitable habitat
- Riparian Area Function – riparian roads, past timber harvest, and livestock grazing have removed riparian forest and limit current riparian function
- Introduced Exotic Aquatic Species – brook trout presence negatively interact with bull trout and increase competition for food and cover

Water quality and quantity, aquatic habitat diversity, fish access and riparian function were the limiting factors prioritized to improve.

Roads/Watershed Assessment Method

The extensive road network is one of the primary drivers impairing current watershed and aquatic ecosystem function. Current road conditions and their potential impacts on watershed and aquatic habitat conditions were assessed. Restorative road treatments are a priority for the Mission Project Area.

Minimum Roads Analysis

In 2010, the Okanogan-Wenatchee National Forestwas directed to conduct minimum roads analysis (MRA) across the entire forest. The objectives of the MRA are too:

- Identify the minimum road system needed for safe and efficient travel and for the protection, management, and use of NFS lands (36 CFR 212.5(b)(1)); and

- Identify roads that are no longer needed to meet forest resource management objectives and that, therefore, should be decommissioned or considered for other uses (36 CFR 212.5(b)(2)).

A key element of this process identifying moderate and high aquatic risk roads. To identify at risk roads, the project fish biologist and hydrologist used an emerging GIS based toolcalled "NetMap" (Benda et al. 2007). NetMap is a GIS based model that uses a digital terrain database and a host of landscape attributes relating to erosion hazards. This model allowed for a rapid evaluation and prioritization of roads that pose varying levels of risk to hydrologic and aquatic resources. The Mission Project MRA fisheries/hydrology risk prioritization methodology used four primary risk factors:

- Shallow Landslide potential associated with roads

- Roads that intersect channel floodplains and ESA critical habitat floodplains

- Erosion risk related to road density upslope from stream reaches

- The potential for roads to divert streams

For each NetMap model output, road segments were identified as low, moderate, or high risk for erosion or other effects to aquatic resources, based primarily on establishment of “Jenks Natural Breaks Classification” creating three classes (determined by ArcMap) of length-weighted average risk scores. In addition to these four risk factors, the risk analysis considered road-stream crossings, as they are the most common sites where sediment is delivered to streams. The cumulative risk scores combined all five criteria and were then sorted into percentiles, with low, moderate, and high risk road rankingsfor each road.

Recommendations for road decommissioning or hydrologic closures were made for roads with moderate or high risk with the goal of reducing the hydrologic/aquatic risks. For example, high and moderate risk ML3 roads were generally recommended for downgrade to ML2 that would allow for more hydrologic disconnection (e.g. drivable dips). High and moderate risk ML2 and ML1 roads were generally recommended for decommissioning.

It is important to note the MRA analysis is not a decision making process; rather it simply is an exercise that evaluates the cost and need for individual roads, the resource risks associated with these roads, and identify potential changes to the road system based on the objectives of reducing maintenance costs, maintaining a safe road network, and reducing environmental risks. Recommendations from the MRA process were taken into consideration for the development for the Mission Project transportation analysis.

Whole Watershed Restoration Procedures Methodology (Roads)

The road assessment procedure used the Draft Okanogan-Wenatchee Whole Watershed Restoration Procedures (WWRP) (USDA 2015). This process identifies where road-stream impacts are potentially and roads or groups of roads that would benefit hydrologic process to remove or hydrologically close.

Since land management activities affecting watershed functionare generally not distributed evenly across watersheds, the roads analysis looked at road-stream interactions at a smaller catchment scale to identify where road-stream impacts are likely to be high. Development of 300-1,500 acre smaller catchments (hereafter referred to as catchments) allowed for greater focus in areas that have the highest degree of road impairment. The ArcHydro tool was used to delineate catchments in the Buttermilk and Libby Creek sub-watersheds. Treatments were determined based on analysis of limiting factors to watershed function. Eighteen catchments were delineated in the Buttermilk and twenty six in the Libby Creek sub-watersheds, shown in Figure 5 (Pink is the project area).

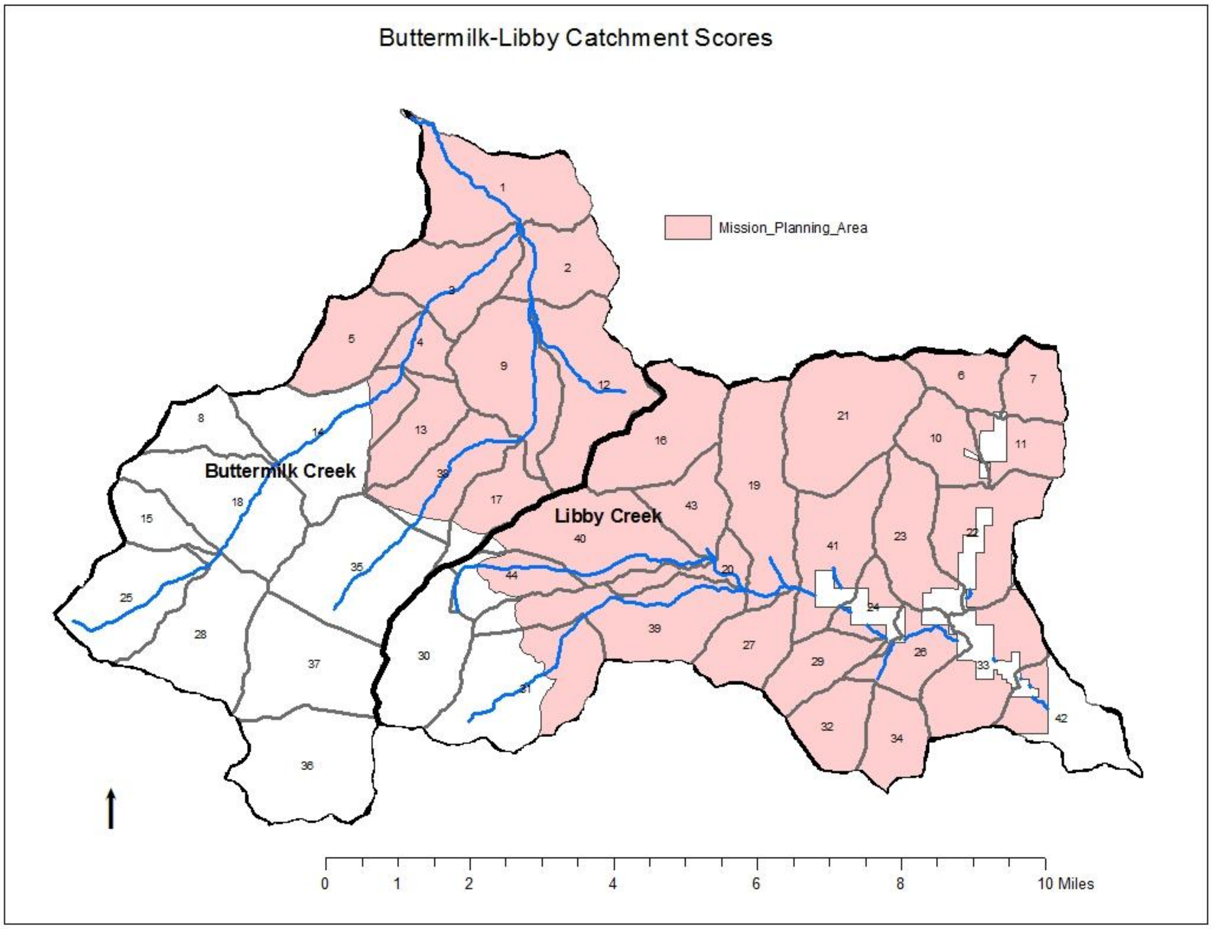

Figure 5.Catchments in the Buttermilk and Libby Creek sub-watersheds.

Road Assessment Procedure

This procedure incorporates geomorphic and ecological principles associated with road impacts in existing watershed and aquatic resource restoration planning mechanisms at varying spatial scales (i.e. Robinson et al 2010 and Rosgen 2006). The physical road indicators assessed include road density, increase in drainage network (artificial streams) from the road system, riparian road density (density of roads within 300 feet of streams), and the number of road crossings per stream mile. These indicators are used to identify where potential road impacts are high and as a proxy to measure the degree of impacts or impairment roads pose to watershed and aquatic resources. High, moderate, and low rankings were assigned to different the indicators based on scientific literature related to road-watershed and aquatic habitat impacts. A rating for each catchment was calculated and assigned a color value based on potential road-stream interaction magnitude and to some degree, a level of departure from historic conditions. Figure 6 displays the indicators, catchment ranking thresholds, catchment rating, and associated color code.

Figure 6. Ranking of physical variables affecting watershed at the catchment scale for the Mission Restoration Project.

Metric	Catchment Ranking Criteria	Catchment Road-Stream Interaction	Catchment Color Assignment
Catchment Road density	0-1 mi/mi^2	Low	Green
	1-2.4 mi/mi^2	Moderate	Yellow
	>2.4 mi^2	High	Red
Increase in drainage network from the road system	0-0.10	Low	Green
	0.11-0.30	Moderate	Yellow
	>0.30	High	Red
Riparian Road Density	0-1 mi/mi^2	Low	Green
	1-2.4 mi/mi^2	Moderate	Yellow
	>2.4 mi^2	High	Red
Road crossings per stream mile	0-1	Low	Green
	1-3	Moderate	Yellow
	>3	High	Red

More details on the method the indicators assessed and calculated is below.

<u>Other Road Assessments</u>

Log truck and public vehicle traffic has been shown to increase road surface erosion on forest roads. For example, Reid and Dunne (1984) estimated that heavily used roads produced 130 times more sediment than abandoned roads. Years of falling road maintenance budgets across the Methow Valley Ranger District has resulted in declining road surface condition. Many high use roads lack adequate gravel and function more like natural surfaced roads. All roads in the project area were field reviewed and most open roads have inadequate crushed rock surfacing. Road-stream crossings are the primary point where vehicle traffic delivers sediment to streams and adequate rock over road-stream crossings can substantially reduce traffic caused sediment delivery to streams (Ward and Seiger 1983). The field review allowed for identification of where road surfaces at stream crossings have inadequate rock surfacing and present likely sources for traffic caused sediment delivery.

Undersized stream culverts constrict channels and are at risk for plugging with debris. When stream culverts plug, road-streams tend to blowout or the road diverts the creek down the road. In both cases, large volumes of sediment are typically delivered to the stream system. Appropriately sized culverts pass more wood and rock moving down streams, making them more resistant to storm events. Climate change modeling indicates flooding frequencies should increase in the future so having appropriately sized culverts is a strategy for making a more resilient road network.Field crews reviewed several stream culverts across the project area to identify undersized pipes.

Aquatic Habitat Assessment Method

In 2010, all National Forests implemented the Watershed Condition Framework (WCF) process, which is a rapid evaluation process that assess sub-watershed (Libby Creek and Buttermilk

Creek) conditions based on land use, roads is similar in intent to that of Watershed Analysis (NWFP 1994). WCF uses an interdisciplinary approach to characterize the health and condition of sub-watersheds on NFS lands. Watershed condition is determined based on the health of hydrologic and soil function in the watershed indicated by physical (water quality and quantity, in-stream habitat, soil productivity, roads and trails, etc.) and biological characteristics (populations and conditions of desired fisheries and impacts of non-native species).

Through the WCF and the Okanogan's Aquatic Watershed Prioritization Process, the Buttermilk Creek and Libby Creek sub-watersheds were identified as having a moderate and high degree of watershed impairment, respectively. Both of these watersheds support ESA listed species and coupled with the level of impairment, they are priorities for restoration.

To determine aquatic habitat conditions and biological hot spots for fish production, the project fish biologist and hydrologist used several sources of information. The Middle Methow, Twisp River, and Lower Methow River watershed baseline updates included in the Biological Assessment (BA) (USDA 2010) and the Mission Project Aquatics Assessment Support Project (Crandall 2016) provided information on the status of fish populations in the project area. Forest Service Level II stream survey reports on major fish-bearing streams in the project area between 2010 and 2011 (USDA 2010, 2011), the above watershed baselines, and field observationsidentified existing aquatic habitat conditions. Fine sediment levels were further analyzed in Libby Creek using a McNeil Core sediment sampler, which looked at the percent fines (<1mm and <0.85mm) in spawning habitat to a depth of ~8 inches. Geographic Information System (GIS) data and field verification identified baseline miles of streams and where streams are perennial or intermittent. Washington Department of Fish & Wildlife (WDFW) spawning ground surveys (Snow et al. 2008) provided data on spawning distribution and abundance of spring Chinook and steelhead. Bull trout spawning distribution and relative abundance came from the most recent Okanogan-Wenatchee National Forest's Draft Methow Sub-Basin Bull Trout Redd Survey Report 2015 (USDA 2015).

NetMap's intrinsic potential habitat for steelhead identified where potential biological hot spots for spawning and rearing exist based on stream gradient, valley width, and average annual stream flow. Bull trout redd surveys provided where high quality bull trout habitat exists for either protection or possible habitat improvement. Restoration treatments were targeted to enhance or maintain quality habitat conditions in these biological hotspots.

From the above surveys and information sources, aquatic habitat conditions were compared to the habitat guidance documents: standards and guidelines from the Okanogan National Forest Land and Resource Management Plan (1989a), the Northwest Forest Plan's Aquatic Conservation Strategy (ACS) (USDA and USDI 1994), and the FWS/NMFS Fisheries Table of Population and Habitat Indicators for use in the Northwest Forest Plan Area (USDA, USDC, USDI, 2004). Additionally, applicable scientific literature relating to desired aquatic habitat conditions helped determine relative "health" or condition of fish habitat and desired conditions.

Project area fish surveys and information from other agencies like WDFW provided information on current fish distribution and potential habitat that is currently blocked by barrier culverts. Restoring passage is a cost effective way to quickly improve habitat conditions for fish. Field review looked at culverts on fish bearing streams and on other streams with suitable habitat to identify where partial or full culvert barriers exist.

Increasing water storage can improve water quantity during low flow periods. The Methow Beaver Project identified suitable beaver release sites across the project area. These sites were reviewed for potential natural water storage capacity as wetland habitat. Additionally, some of the drier south facing sub-drainages in Libby Creek area were identified for riparian thinning to promote hardwood development to attract beaver use in the future.

Resource Indicator Summary

Resource Indicator: Road Density

Several road metrics provide a means to assess the potential effects and risk of roads. Road density can be a measure of hydrologic and aquatic impacts at a watershed or sub-watershed scale (Lee et al. 1997, McCafferty et al. 1997). Road densities of <1 mi/mi^{2}are considered low enough to support proper watershed and aquatic function (FWS 1998). Road densities of 1 to 2.4 mi/mi^2 are considered functional at risk, and road densities >2.4 mi/mi^2 are considered not functional (Lee et al. 1997). For example, Lee et al. (1997) found watersheds containing road densities over 1 mi/mi^2 to have degraded habitat and depressed local populations of bull trout and cutthroat trout and where densities exceeded 2.4 mi/mi^2, fish populations became nonexistent. The project acknowledges road densities are aptly used at assessing hydrologic processes and aquatic habitat conditions at the watershed or sub-watershed scale and not at the smaller, catchment scale size. As such, the road density was used for identifying where potential road-stream interactions are high and not to assess catchment condition.

Using GIS, road density was calculated at the catchment scale using all road miles (maintenance level 1-5 and unauthorized roads) divided by square miles of land within each catchment. For the project effects analysis, changes in road densitywas compared between the existing condition, no-action alternative, and proposed action alternatives. Changes in road densitywere discussed with the assumption that reduced road densities would be a beneficial effect to hydrologic and aquatic resources at the sub-watershed scale.

Resource Indicator: Increase in road drainage network

Roads in forested watersheds are often connected to streams hydrologically. Logging roads can increase the stream network by intercepting subsurface flow and transporting surface water on the road surface, ditchlines, and down cross-drain culverts (artificial streams). As an example, Wemple et al. (1996) documented 50% of roads located in the central Oregon Cascade Mountains were connected to a stream network.Hydrologically connected roads increase the rate watersheds drain and increase the magnitude and frequency of peak flows, particularly for small floods (Wemple et al. 1996). Potential effects can range from localized sites (plugged culverts, localized landslides, etc.) to broad watershed scale effects, such altering timing of peak flows.

Changes in peak flows, such as increased ow frequency, can alter channel scour that leads to negative impacts to fish. Altered channel scour can influence the survival of fish embryos incubating within stream gravels (e.g. Montgomery et al., 1996). For example, scour events more frequent than the life span of bull trout (~8 years on average) can reduce the embryo survival and reduce population abundance (Tonina et al. 2008).

Increase in drainage network from the road system was calculated using miles of road that are hydrologically connected to the stream network. Specifically, this indicatoris the ratio of the length of all the road segments that drain within 300' of the streams to the total length of streams in the catchment. This metric provides a useful proxy for degree of hydrologic impact from the road system.

For the project effects analysis, changes in the road drainage networkwas compared between the existing condition, no-action alternative, and proposed action alternatives. Changes in road drainage network from the proposed road treatments were discussed in context of how it changed the indicator at the catchment scale and would affect hydrologic and aquatic habitat resources at the sub-watershed scale.

Resource Indicator: Riparian Road Density

The interactions between forest roads and aquatic/fish resources are well documented in the literature (Cederholm and others ; Ketcheson and Megahan 1996; Trombulak and Frissell 2000)(Megahan 2001). Though roads typically provide a range of public benefits, their construction and presence can alter watershed-scale hydrologic and ecological processes as described in this document.

Road impacts are greatest in the zone near stream channels. Ketcheson and Megahan (1996) found road features like relief culverts can deliver sediment ~300 feet away from a road. Other aquatic/riparian impacts include direct habitat loss, loss of tree production and woody debris recruitment, habitat fragmentation, increased sediment delivery, reduced stream shade, stream channelization, and increased human impacts (Wisdom et al. 2000). Riparian road density provides a more targeted approach to identify where road-stream impacts likely occur than overall road density.

The WWRP calculates the density of road segments within 300 feet of streams as proxy for road-stream impacts such as sediment sources, loss of instream wood recruitment, and channel constriction. Riparian road density was calculated by the ratio of miles of roads within 300 feet of streams to the square miles of area within 300 feet of streams, by catchment. For the project effects analysis, riparian road densitywas compared between the existing condition, no-action alternative, and proposed action alternatives. A limitation in this indicator was it only estimates the density of roads within RRs, but does not account for amount of roads in the catchment. A catchment with a low overall road density could still have a high riparian road density, which would give a false risk factor. To address this, we averaged the catchment road density and riparian road density to identify where both catchment road density and riparian road density is moderate and high. Changes in road density from the proposed road treatments were discussed in context of how it changed the indicator at the catchment scale and the effects to hydrologic and aquatic resources at the sub-watershed scale.

Resource Indicator: Stream Crossings per Mile

Coe (2006) found road-stream crossings accounted for about 60% of all connected road segments and thus stream crossings provide the overriding mechanism for sediment delivery streams.McCaffery et al. (2007) found fine sediment levels in streams increased with increasing number of stream crossings, suggesting it is a good measure of stream conditions. The WWRP uses stream crossing densities (stream crossings per mile) as a proxy for land use intensity and hydrologic and aquatic resource conditions at the sub-watershed scale.

The stream crossings per mile metric was calculated as the total stream crossings (fords, culverts, bridges) within each catchment by the total miles of streams. For the project effects analysis, stream crossing density was compared between the existing condition, no-action alternative, and proposed action alternatives. Changes in stream crossing density from the proposed road treatments were discussed in context of how it changed the indicator at the catchment scale and would change hydrologic and aquatic resource conditions at the sub-watershed scale.

Resource Indicator: Ground Cover

Effective groundcover describes rock, living and dead herbaceous and woody materials in contact with the ground >3/4" in diameter that would protect the soil surface from erosion (Soil Management Handbook, USDA, 1992). To ensure the efficacy of vegetative buffers within the RRs, > 90% vegetative ground cover provided by trees, shrubs, grasses, sedges and duff should be maintained ((RTT) 2013). Effective groundcover within RRs should trap and filter sediment from entering streams or wetlands below treatment areas to prevent fine sediment from entering streams.

To meet acceptable levels of soil loss and soil management objectives, the following minimum percent effective ground cover following cessation of any soil-disturbing activity should be maintained outside of RRs (Figure 7).

Figure 7. Minimum Percent Effective Ground Cover (R6 Standards)

Erosion Hazard Class	1st Year	2nd Year
Low (Very slight-slight)	20-30	30-40
Medium (Moderate)	30-45	40-60
High (Severe)	45-60	60-75
Very High (Very Severe)	60-90	75-90

Changes in ground cover will be analyzed by how much bare soil is created (acres) by management activities; primarily prescribed burning, temporary road construction (including unauthorized roads), pile burning, and landing construction. For the project effects analysis, change in bare soil acres was compared by Alternative 2 and 3 using Forest corporate and project spatial (GIS) data, between the existing condition, no-action alternative, and proposed actions. Changes in bare soil acres were discussed in context of how it affect surface erosion and sediment delivery to the stream network.

Resource Indicator: Beaver Habitat

Historically, beavers created stream systems with slow, deep water and floodplain wetlands that play an important role diversifying stream and riparian habitat and providing water storage to supplement summer base flows. Private irrigation ditches and water transmission lines in lower Buttermilk Creek and Libby Creek remove water resulting in reduced summer and fall base flows.Low stream flows reduce available refugia from predators, elevates water temperatures, reduces migratory habitat, reduces availability of food, and increases competition for space. The Methow Beaver Project identified historic beaver population levels in the project area.

The proposed beaver enhancement (BE) project involvesthe release of beaver at suitable siteswithin the Mission Project area along with active treatments encourage beaver use and increase success rates. These active treatments include:

- The construction of beaver dam equivalents (BDAs)
- Tree girdling and commercial harvest of conifers to promote hardwood vegetation and beaver forage production (~68 acres)
- Falling trees into the channel for additional complexity and pool formation in BE areas as needed
- Riparian fencing to keep cattle out of wet meadows while beavers establish themselves
- Soil restoration (sub-soiling) is also occurring in concert with BE areas, but it is not limited to only these areas (This will increase the soil water holding capacity and infiltration rate in the riparian areas and help to increase water yield) (See Soils Report)

BE sites have been selected based on exhibiting suitable gradient, presence of surface water and an identifiable stream channel, availability of forage and dam building materials, and potential for long-term success and restoration. For the project effects analysis, each beaver release site would be a measure for assessing changes in natural water storage and water quantity at the sub-watershed scale.

Resource Indicator: Stream Channel Complexity

Large wood is important for reducing river energy, forming pools, and adding overall habitat complexity. Desired wood quantities and size classes were developed from two sources. Fox and Bolton (2007) conducted an inventory of wood quantities in unmanaged or lightly managed streams in the eastern Cascade Mountain range. They suggest a range of wood loading that is characteristic of natural systems. The DesiredCondition Report (Shull and Butler 2014) provided additional information on desired wood loading which summarizes the range of desirable wood levels (number of pieces) based on local rivers, new scientific research, and federal land management direction. This document defines a range of wood pieces per mile, key pieces per mile (greater than 32 inches dbh), and log jams per mile that would occur under properly functioning wood conditions.

The desired density of wood greater than 6 inches diameter is in the range of 105 to 270 pieces per mile. Desired density is 2 – 5 pieces/mile of larger key wood with diameters greater than 18 inches and 35 feet long

To identify the existing instream wood quantities, we relied upon recent aquatic habitat inventory data collected in 2010 and 2011 (USDA-FS 2010 and 2011). Wood quantities and size classes from these reports was compared to the above desired quantities. This allowed the project hydrologist and fish biologist to determine where existing wood levels are compared to desired conditions.

The proposed wood treatment is to hand fall small to large sized trees into key locations with deficient wood levels in the Buttermilk and Libby Creek drainages. The unit of measure for assessing the changes to habitat diversity will be miles of stream improved with wood placement.

Resource Indicator: Fish Distribution

Fish in the Mission Project area include resident, anadromous, and Columbia Basin migratory species. Addressing connectivity is a high priority, cost-effective approach to protecting and restoring fish populations. Improving connectivity can increase habitat diversity and population resilience.This can reduce effects of climate change-induced reductions in stream flow and increases in temperature.

The proposed barrier removal treatment is to replace road culverts that partially or fully block fish passage with aquatic organism passage pipes (AOP). Structures such as bottomless arches provide full passage to all fish life stages as well as to all other riparian dependent species. The unit of measure for assessing the changes to fish distribution will be the number of barrier culverts replaced with AOPs and miles of habitat with new access or improved access.

Impact Framework and Duration Definitions

Impact topics have been selected for this analysis based on their potential to affect important resources and other key issues identified during planning. Because of the inherent uncertainty involved with adaptive management strategies, analyses in this section are qualitative assessments based on review of scientific literature and information collected by the field specialists and provided by other agencies.

Nature of Effect for Hydrologic and aquatic Resources

Direct—an effect that is caused by and occurs at the same time and place as the proposed activity. This could be an affect to individual fish or an aquatic or hydrologic habitat indicator like stream flow or instream wood levels.

Indirect—a reasonably foreseeable effect that is caused by the proposed activity, but occurs later in time or farther removed in distance. Examples include increased fine sediment levels in fish habitat from blading roads or increased base flows from increasing beaver habitat.

Context of Effect for Hydrologic and aquatic Resources

Beneficial—Moves the system to or towards desired conditions (water yield, peak flows, sediment yield, nutrient yield or stream system response, and stream channel morphology) and fish abundance improves or maintains robust local populations. For example, replacing barrier culverts would improve fish access to spawning habitat, moving the project area closer to desirable fish habitat conditions and increase local population abundance.

Adverse—Moves the system outside of or away from the desired conditions (water yield, peak flows, sediment yield, nutrient yield or stream system response, and stream channel morphology) and fish abundance improves or fish abundance improves or maintains robust local populations. An example would be soil compaction in RRs would lead to increase runoff patterns and reduced base flow conditions.

Duration of Effect for Hydrologic and aquatic Resources

Short-term—an effect that would not be detectable within a short amount of time, generally within hours to a few weeks after the proposed activity has been carried out. For example, dropping trees into a stream would temporarily increase suspended sediment levels, but it would be undetectable after a few hours.

Long-term—a change in a resource that will not return to its condition prior to the activity for the foreseeable future. An example includes completelyremoving overstory trees along a stream could increase stream temperature for years.

Effect Intensities for Hydrologic and Aquatic Resources

Negligible: A change that would be so small that it would not be of any measurable or perceptible consequence. Aquatic or hydrologic resources would not be affected or the effects on these resources would not be detectable. An example includes opening a closed road that does not cross any streams or wetland areas.

Minor: A change that would be small and localized and of little consequence. Effects on aquatic or hydrologic resources would be detectable, although these effects would be localized, short-term, and inconsequential. An example would be the sediment effects generated from replacing a single stream culvert using BMPs.

Moderate: A change that would be readily apparent and measurable, localized, and possibly long-term. Measurable effects could include a substantial sediment delivery disturbance, removal of large amounts of riparian trees, or a positive effect would be a reduction in multiple stream crossings in drainage area. Mitigation measures proposed would help off-set adverse effects.

Major: A noticeable change to a physical resource that would be measurable and result in a severely adverse or major beneficial impact. Effects on hydrologic resources would be readily apparent, measurable, severe, long-term, and felt on a regional scale. Substantial watershed features would be removed or the physical properties significantly altered. Mitigation measures proposed to offset adverse effects would be extensive and success would not be assured.

Development of Restorative Road Treatments

Restorative road treatments were developed using theDraft WWRP (USDA 2015) and from field review of existing road infrastructure in the project area. This WWRP procedure incorporates geomorphic and ecological principles found in existing watershed and aquatic resource restoration planning mechanisms at varying spatial scales (i.e. Robinson et al 2010 and Rosgen 2006). This strategyprioritized road treatmentsin catchments rated as havingmoderate or high road-stream interactions.This targetsrestoration efforts in the areas roads are likely causing the greatest resource damage. Restoration objectives included reducing artificial sediment sources, reducing road drainage networks, increasing riparian function where roads parallel streams, increasing resiliency of roads to anticipated higher frequency flooding, increasing summer base flows, and restoring fish passage on barrier culverts.

Through the road assessment process, the following restorative road treatments were identified and proposed for the Mission Project:

- Riparian road decommissioning and hydrologic closure
- Rock armoring of stream crossings on open roads with greater than 3% slopes
- Replacing undersized stream pipes with ones that accommodate 100-year flow events.
- Converting select small stream crossings to hardened fords
- Replacing barrier fish pipes with “aquatic organism passage” structures that can accommodate passage for all aquatic and riparian dependent species.

Development of Aquatic Habitat Restoration Treatments

Habitat restoration treatments were developed through the identified aquatic habitat limiting factors and potential treatments feasible to implement under this project. The following treatments were identified and proposed for the Mission Project:

- Adding coarse wood to stream reaches that are biological hot spots or have potential to be highly productive.
- Releasing beaver pairs in suitable habitat to promote wetland development for increased natural water storage.

Existing Condition

The Mission Project area encompasses approximately 31,700 acres within the Twisp River (1702000805) and Lower Methow River (1702000807) watersheds. The project area includes the lower portions of the Buttermilk Creek (170200080506) and Libby Creek (170200080701) sub-watersheds, which are approximately 23,500 and 25,500 acres in size, respectively (Figure 8). The project boundaries correspond to watershed boundaries except for a small piece near the bottom of Buttermilk Creek that lies within the Mainstem Lower Twisp River sub-watershed. Activities in this area are minor with no effects to hydrologic or aquatic resources and will not be discussed further. There are ~30 miles of perennial streams and ~14 miles of intermittent streams within the project area boundary.

Past management practices, including fire suppression, changed forest vegetation structure, overstory and understory species composition, and spatial patterns have been altered in comparison to historical conditions in riparian areas within the project area.These conditions also make riparian areas more susceptible to uncharacteristic harmful effects caused by wildfire.Ladder fuel reduction (LFR) and prescribed burning are treatments proposed to make stands in riparian areas more resilient to the impacts of uncharacteristic wildfire. They will be discussed in detail within the fuels section of the EA.

Figure 8. Watershed and Treatment Areas by 10th and 12th Field HUC: (USFS GIS data)

HUC	HUC name	Acres	% of HUC5 area	Project planning area acres	% of HUC5/6 area
170200080507	Buttermilk Creek	23,500	99	10,900	~46
170200080701	Libby Creek	25,500	92	22,670	~89

Buttermilk Creek Sub-watershed Description

The headwaters originate at the confluence of the West and East Forks of Buttermilk Creek, which both originate within alpine cirques in the Chelan-Sawtooth Wilderness at elevations of 7,000’-8,600’. Both forks flow for approximately nine miles before joining at RM 2.6 and provide the majority of stream flow in the watershed. Downstream from this confluence, Buttermilk Creek flows through a steep canyon to join the Twisp River at RM 12. Perennial tributaries in the watershed include Black Pine Creek, which flows into the East Fork approximately 0.5 miles upstream of the forks confluence. Several other intermittent streams enter into the West and East Forks and mainstem.

Buttermilk Creek covers about 23,500 acres and almost all of the land (99%) is managed by the Okanogan-Wenatchee National Forest. Much of the Twisp Watershed including all of Buttermilk is a Tier 1 key watershed identified under the NWFP as important in contributing to the conservation of anadromous salmonids, bull trout, and other resident fish species. About 12,200 acres of Buttermilk (about 52%) is within the Lake Chelan-Sawtooth Wilderness. The remaining ~11,300,000 acres consist of multiple use management. A watershed analysis was completed in 1995 (USFS 1995).

Annual precipitation in the area ranges from 90 inches along the Cascade crest to 20 inches near the mouth. The elevation ranges from 8,500 feet at the upper ridges to 1,300 feet at the confluence with the Methow. Most precipitation comes during the winter as snow.

Libby Creek Sub-watershed Description

The headwaters of Libby Creek originate in alpine cirques and several lakes within the Chelan-Sawtooth Wilderness at elevations of 6,800’-8,400’. Libby Creek proper is formed by the confluence of its two primary forks, the North Fork and South Fork at river mile (RM) 7.2, and these two tributaries contribute approximately 60% of stream flow to the mainstem (USFS 1998). Libby Creek flows in an easterly direction for approximately 14 miles to its confluence with the Methow River at RM 26 just downstream from the town of Carlton at an elevation of 1,360’. Other tributaries to Libby Creek include Smith Canyon, Chicamun Canyon, Ben Canyon, Mission Creek, and Hornet Draw. These streams are mostly perennial but may flow intermittently in low water years and when water diversion volumes exceed instream flow.

Several other intermittent creeks and draws also contribute to the instream flow especially during spring runoff.

Libby Creek sub-watershed covers 25,500 acres and most of the land (92%) is managed by the Okanogan-Wenatchee National Forest. About 3,000 acres of Libby (about 11%) is within the Lake Chelan-Sawtooth Wilderness. The remaining ~22,400 acres consist of multiple use management. A watershed analysis was completed in 1995 (USFS 1995).

Precipitation is light in the summer increases in the fall reaches peak in winter and then gradually decreases in the spring. Annual precipitation varies from about 10 inches at the mouth of Libby Creek to over 40 inches at the highest elevations in the watershed. At the lower elevations 35-40% of the precipitation falls as snow while at the higher elevations 55-65% of the precipitation falls as snow.

Both the Buttermilk and Libby Creek sub-watersheds experienced decades of timber harvest, fire suppression, livestock grazing, illegal firewood cutting, dispersed recreation impacts, and road construction with varying effects to aquatic and riparian resources. Implementation of the NWFP and ESA listing of fish species has substantially reduced activities and impacts within RRs.

Water Quality

The Forest Plan directs that the assessment of cumulative watershed effects to water quality be discussed in terms of the 10th field HUC watershed boundary. The Washington Department of Ecology, Water Quality Assessment for Washington has sampling locations downstream from the proposed project area on the lower Twisp River and lower Methow River. There are no locations within the Twisp River Watershed (HUC 10) with a 303(d) Category 5 listingand one 303(d) listed site in the Lower Methow River Watershed downstream of the project area. The Methow Rivernear the confluence with the Columbia River is listed for pH and water temperature.

Water quality parameters (Washington State Water quality criteria specific to aquatic habitat parameters) most likely susceptible to change by vegetation and fuels treatments are turbidity fine sediment and temperature. This project would not impact these parameters where the sampling locations exist.

Fish Species and Habitat

The project analysis area contains habitat for fish species listed under the ESA, Regional Forester’s Sensitive Species, Management Indicator Species (MIS), and species for which Essential Fish Habitat (EFH) has been designated under the Magnuson-Stevens Fishery Conservation and Management Act (Figure9).

Figure 9. Fish species present in the project analysis area by category.

ESA	R6 Sensitive	MIS	EFH
Spring Chinook (Endangered)	Westslope Cutthroat	Spring Chinook	Chinook
		Westslope Cutthroat	Coho
Summer Steelhead	Interior Redband	Interior Redband	

(Threatened)	Rainbow	Rainbow	
Bull Trout (Threatened)		Steelhead	
		Bull Trout	
		Eastern Brook Trout	

Both the Buttermilk and Libby Creek drainages contain federally endangered Upper Columbia River Spring-run Chinook, threatened Upper Columbia River steelhead, and Columbia River bull trout. Buttermilk Creek is designated critical habitat for Spring Chinook, summer steelhead, and bull trout. Libby Creek is designated critical habitat for steelhead only. Figure 10 below displays the fish distribution and where critical habitat is designated.

Bull trout use WF and EF Buttermilk Creeks for spawning and rearing.The mainstem of Buttermilk Creek is used for foraging and migrating to and from spawning habitat. Limited bull trout use occurs in Libby and no known spawning. Steelhead spawn and rear in Buttermilk and Libby Creeks. Juvenile spring chinook use the lower portions of Buttermilk and Libby Creek for rearing.

Genetically pure interior redband rainbow trout (IRRT) are found in the Buttermilk Creek sub-watershed, with particularly good examples in West Fork Buttermilk Creek. The rainbow trout in Libby Creek has shown mixing with coastal rainbow trout strains as well as with cutthroat, suggesting they are not pure IRRT.

Westslope cutthroat trout (WSCT) is within Buttermilk and NF Libby creeks (Proebstel et al. 1998). WDFW continues to stock many mountain lakes in the sub-basin with WSCT, which has artificially increased WSCT's range in the sub-basin. Cutthroat trout likely occur elsewhere in the analysis area, though genetic data are not available for all streams.

Eastern brook trout are present Libby Creek and the lower mile of NF Libby Creek. They are not native to the Columbia River Basin; however, as they are resident fish, they are considered a MIS species.

River Lamprey, Umatilla Dace, and Pygmy Whitefishare each Forest Service Regionally Sensitive Species located on the Okanogan-Wenatchee National Forest. None are known to occur in the Methow Sub-basin.

Figure 10. Summary of fish distribution in project streams and designated critical habitat (CH).

Species[1]	**SCS**		***O.m.***		**BT**		**WSCT**	**EBT**
	Dist.[2]	**CH**	**Dist.[2]**	**CH**	**Dist.[2]**	**CH**	**Dist.[2]**	**Dist.[2]**
Buttermilk Cr.	1.1	1.1	2.5	2.4	2.5	2.5	2.5	- -
West Fork Buttermilk Cr.	- -	- -	2.9	- -	2.9	2.9	- -	- -
East Fork Buttermilk Cr.	- -	- -	5.5	- -	5.5	5.5	2.2	- -

Libby Creek	2.5.	- -	6.0	3.4	6.0[3]	- -	3.0	1.0[3]

[1] **SCS** - spring Chinook; ***O.m.*** – *O. mykiss*, includes IRRT, steelhead and resident rainbow trout of unknown genetics; **BT -** bull trout; **WSCT -** westslope cutthroat; **EBT** – eastern brook trout

[2] Known distribution in miles.

[3] Based on limited data

Aquatic habitat conditions within the project area are generally in fair condition with some properly functioning elements. Fish population levels in the analysis area are largely driven by actions that occur outside of the Methow Valley such as dams, commercial harvest, and hatcheries. Within the project area, habitat deficiencies include low base flows, low instream wood levels, excessive summer water temperatures (Libby Creek), elevated fine sediment in fish bearing tributaries, and habitat loss on in some private lands in the lower Buttermilk Creek, and Libby Creek.

Salmon and trout are sensitive to accumulations of fine sediment in spawning grounds and juvenile rearing habitat. Fine sediment defined in the fish literature often corresponds to a size class of less than 1mm (Koski 1966) and up to 9.5mm (Tappel and Bjornn 1983). Excessive fine sediments in spawning gravels prevent the ability of clean, oxygenated water from flowing through redds which is important for providing sufficient oxygen to embryos and removing feces wastes (Meehan, 1991 and Goetz, 1989). Low fine sediment levels are important for juvenile rearing because space in larger substrates provides cover for young fish in summer and winter. Newly emerged fry need voids in gravel to hide and feed and larger fish need space among cobles and boulders for the same purposes. A streams carrying capacity declines when fine sediment levels fill in the interstitial space of substrates and this was observed when percent fines (<6mm) exceeded 10% (Bjornn and Reiser 1991). Excessive sedimentation rates can cause channel widening and sediment deposition can result in disconnection of side-channel habitat and reduce depth and quality of pool habitat. This reduces the availability of off-channel rearing habitat for juveniles during spring peak flows.

Okanogan Forest Plan standard 3-3 states that fine sediment levels in spawning areas should not exceed 20% for the <1mm size class (USFS 1989). From scientific studies done on salmon egg and fry survival at different fine sediment levels, the most impacting particle sizes to spawning are <0.85mm (Cederholm and Reid 1987), when measured at depth. The FWS/NMFS Fisheries Matrix of Pathway Indicators (referred to as MPI henceforth) (USDA-FS and others 2004) set properly functioningfine sediment levels of spawning habitat for particles<0.85 mmat less than 12%, functioning at risk levels at 12-17%, and not functioning levels at greater than 17%. Additionally, the MPI sets properly functioning surface fine sediment levels for particles less than 6mm at <12%, functioning at risk levels at 12-20%, and not functioning sediment levels at >20%. Therefore, sub-surface fines <0.85mmless than 12% and surface fines<6mm less 12% are the desired condition for fish habitat (USDA, USDC, USDI, 2004).

To assess fine sediment levels in the project area streams, the project hydrologist and fish biologist used recent pebble count data and McNeil core sediment samples collected in the project area. Pebble counts were completed using the Wolman Pebble Count method (Wolman 1954) which measures particle sizes less than 6mm. Twenty three pebble counts were collected across the Buttermilk and Libby Creek drainages with focus on the main fish streams. McNeil Core sediment samples were collected at two locations in Libby Creek. The sediment data is shown in the Figures 11 and 12 below.

Figure 11. Pebble count data from the 2011 Buttermilk Creek Stream Survey Report and 2010 Libby Creek Stream Survey Report.

Survey Location	Year	Pebble Count Site	% fines <6mm	Sediment Rating
Buttermilk Creek Reach 1	2011	1	10	PF
East Fork Buttermilk Creek Reach 1	2011	1	8	PF
East Fork Buttermilk Creek Reach 2	2011	1	5	PF
West Fork Buttermilk Creek Reach 1	2011	1	1	PF
West Fork Buttermilk Creek Reach 2	2011	1	6	PF
West Fork Buttermilk Creek Reach 3	2011	1	11	PF
Libby Creek Reach 2	2010	1	19	FAR
Libby Creek Reach 3	2010	1	26	NF
Libby Creek Reach 4	2010	1	17	FAR
Libby Creek Main by HD 1	2010	1	14	FAR
Libby Creek Main by HD 2	2010	1	13	FAR
Libby Creek Main by HD 3	2010	1	16	FAR
Libby Creek Main by HD 4	2010	1	21	NF
North Fork Libby Reach 1	2010	1	14	FAR
South Fork Libby Reach 1	2010	1	23	NF

Figure 12. McNeil Core sediment data for Libby Creek collected in 2011.

(<1mm)		
Libby Creek Sites	% Fine Sediment	Sediment Rating
Upper	14	FAR
Lower	15	FAR
Average Fine Sediment Libby Creek	**16**	**FAR**

(<0.85mm)		
Site	% Fine Sediment	Sediment Rating

Upper	13	FAR
Lower	12	FAR
Average Fine Sediment Libby Creek	**13**	**FAR**

Pebble count data (USFS 2011) suggest Buttermilk is properly functioning for fine sediment levels. There are riparian roads and hillslope failures from past logging activities that contribute excess sediment to the stream system but the data suggests sediment is not a problem in fish habitat. It is important to note that Buttermilk Creek, including the WF and EF Buttermilk Creek tributaries are mostly steep gradient channelswith high sediment transport capacity. Most fine sediment in the drainage is transported to the Twisp River which is generally low in fine sediment levels (USDA 2011 amp BA). Very little bank erosion exists in the fish bearing streams, further indicating the sediment regime is properly functioning.

Fine sediment levels are elevated within the Libby Creek drainage. Three out of the nine sites monitored had surface fines not functioning and the other six sites were functioning at risk. The McNeil Core sediment data suggests the percent fines less than 0.85mm in spawning habitat is functioning at risk. Fine sediment levels less than 1mm were below the Okanogan Forest Plan standard. Bank stability in the main fish streams was greater than 95%, which is considered excellent. Some tributary streams are receiving bank damage from livestock, but it has been minor across the sub-watershed.

The higher fine sediment levels is likely do the high road density in several areas across the sub-watershed.Fine sediment within the Libby Creek drainage is functioning at risk and below desired levels for fish production.

Resource Indicator Summary

Resource Indicator: Road Density

The road network changes the way watersheds handle runoff.They also deliver more sediment into the system at crossings or when they are placed adjacent to a stream. There are about 54 miles of road within the Buttermilk Creek drainage and 78 miles in the Libby Creek drainage.

Road densities for the Buttermilk and Libby Creek drainages are generally lower than other many other areas across the Methow Valley Ranger District, but are within the functioning at risk category. Figure 13below shows the road density at the sub-watershed scale.

Figure 13. Total road miles and road density at the sub-watershed scale.

Row Labels	Total road miles	Sub-watershed Acres	Sub-watershed Road Density
Buttermilk Creek	54.4	23500	1.3
Libby Creek	76.1	25500	2.1
Grand Total	**130.5**		

Scaling down where more localized road-stream interactions occur, the WWRP calculated road densities at the catchment level. Existing catchment road densities across the Mission Project area are shown in Figure 14. Road density is highacross 36 percent (13 total) of the catchments and moderateacross about 20 percent (11 total).Most of the low catchments are in wilderness. This indicates negative road stream interactions are likely occurring in the lower and eastern portion of the Buttermilk Creek drainage and in the upper and middle portion of the Libby Creek drainage.

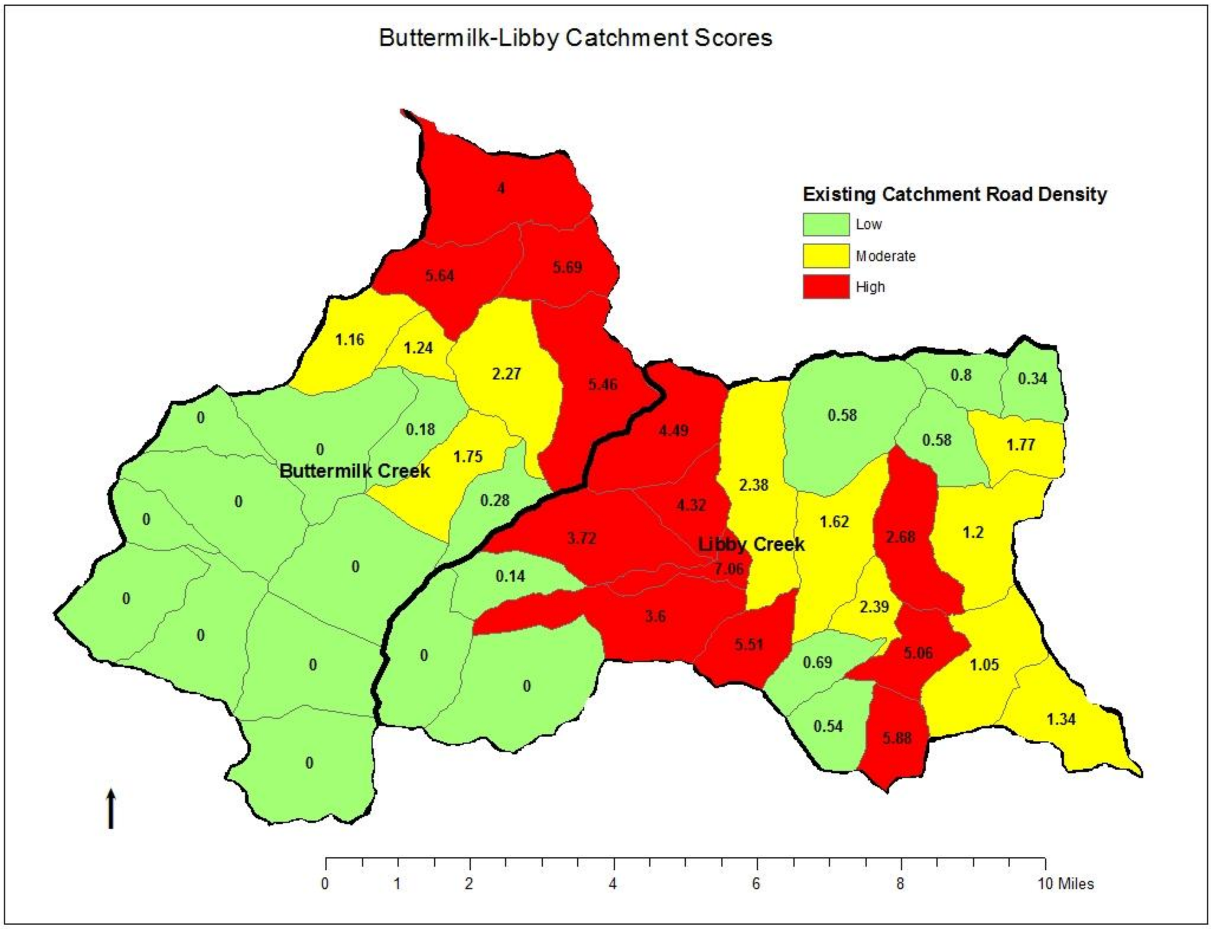

Figure 14. Road density across the Mission Project catchments.

Resource Indicator: Road Drainage Network

Increases in drainage network from the road systemacross the Buttermilk and Libby Creek sub-watersheds are shown in Figure 15. Over 40 percent of catchments are within the high category and over 20 percent are in the moderate category for this metric indicating that hydrologically connected roads are one of the primary drivers of impaired function in the Mission Project area. The lower third of the Buttermilk Creek drainage has a substantial increase in artificial streams as does most of the Libby Creek drainage. This suggests that peak flows are likely higher in the Libby Creek drainage and to a lesser degree in the Buttermilk drainage as well.

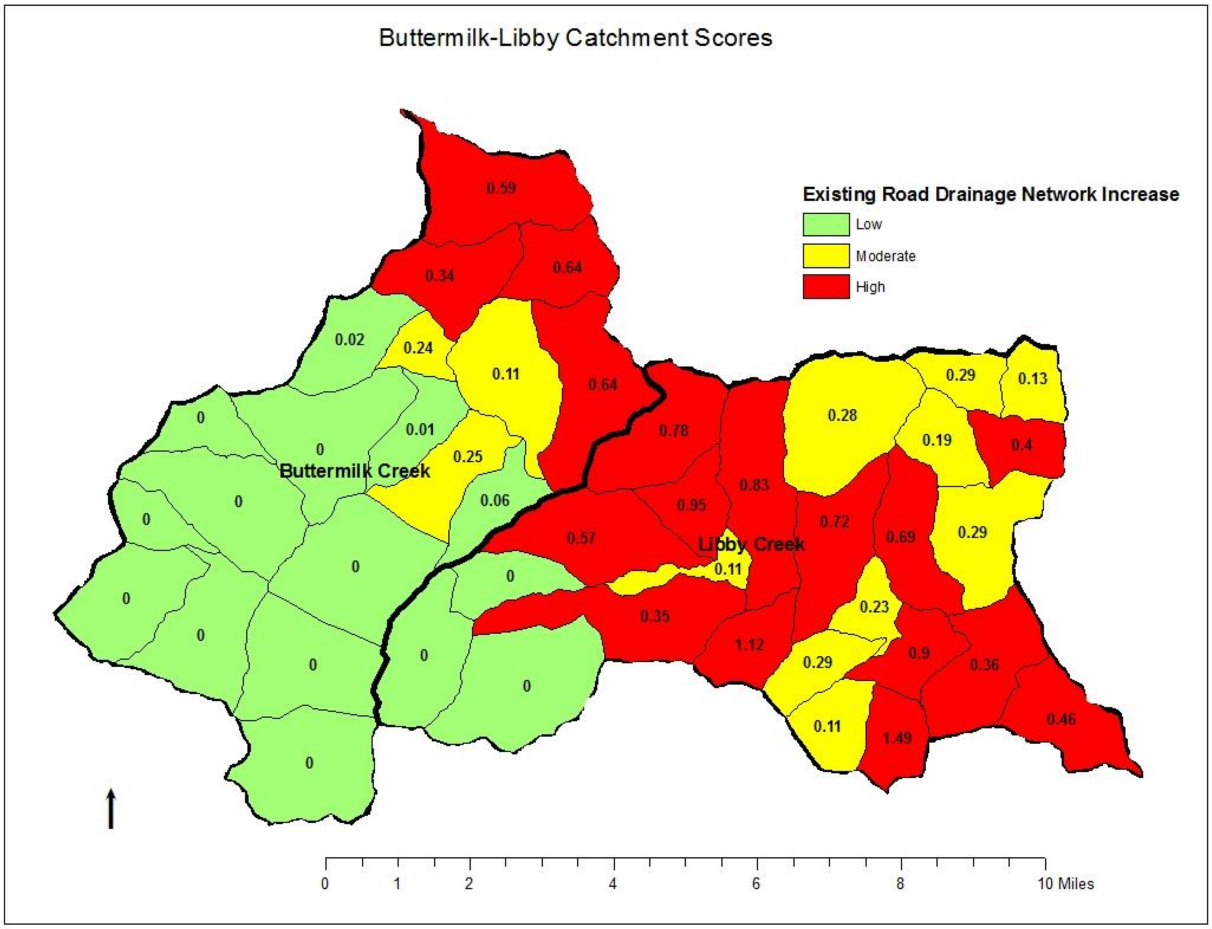

Figure 15. Increase in drainage network from the road system across Mission Project catchments.

Resource Indicator: Riparian Road Density

Figure 16shows the current riparian road density levels and rating by catchment across the project area. Fifty percent of the catchments are rated high and thirteen percent rated moderatefor riparian road density indicating where riparian roads are abundant and greater potential for negative road-stream interactions. This indicator is somewhat misleading because it over estimates negative road-stream interactions. The red catchment in top center of Libby Creek hasa riparian road density of 2.6, but is not a big concern because the total road density is 0.6 mi/mi^2. The catchment road density and riparian road density were averaged to identify where general road density is high and high within RRs. These areas have the greatest potential for negative road-stream interactions to occur. Figure 17shows the combination of catchment and riparian road density.

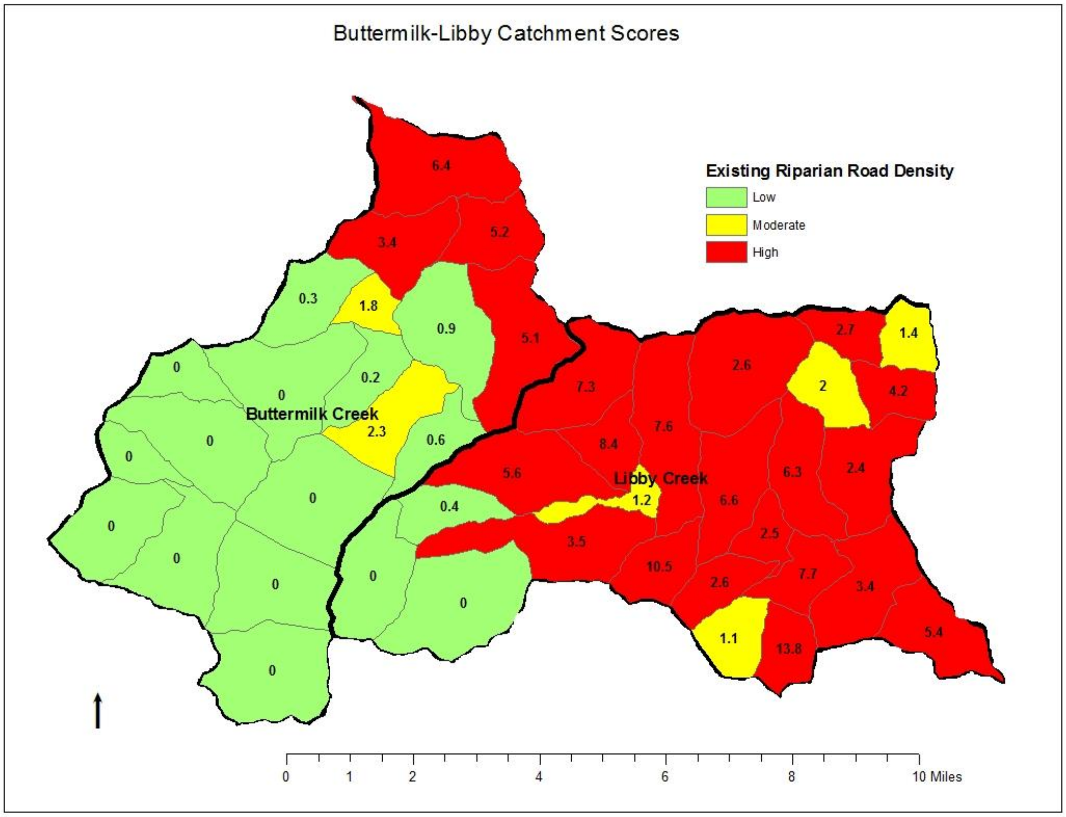

Figure 16. Existing riparian road density across Mission Project catchments.

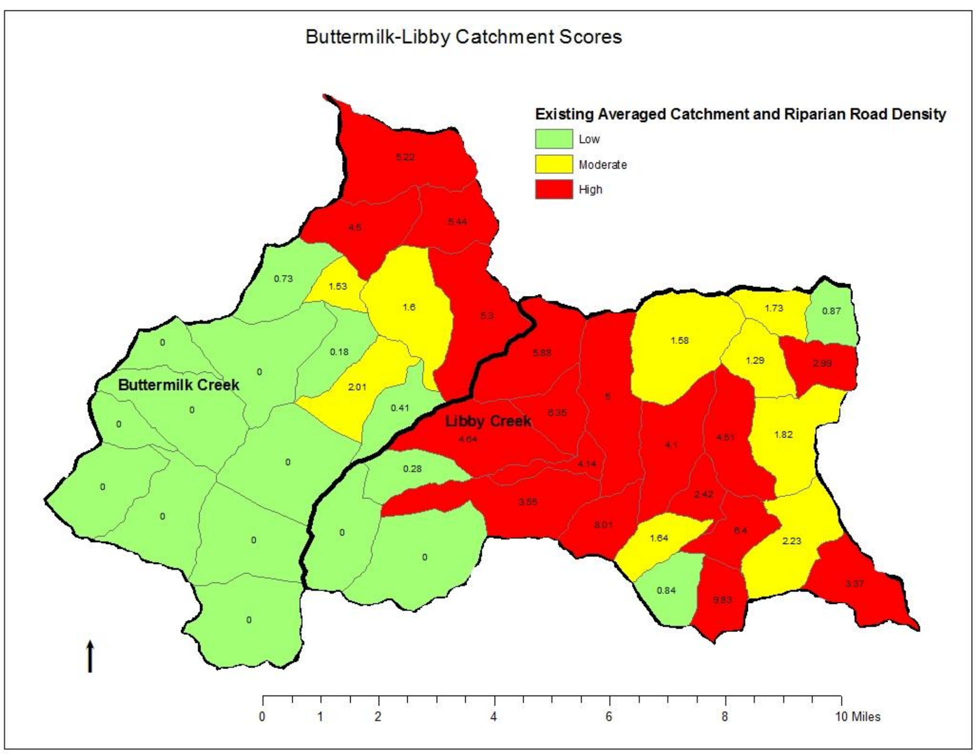

Figure 17. Existing Averaged catchment and riparian road density across Mission Project catchments.

Resource Indicator: Stream Crossings per stream mile

The number of stream crossings per mile of stream within the Mission Project are shown in Figure 18. Manycatchments are rated low for this indicator but this is mostly due to the wilderness in the sub-watersheds. Focusing on just the project areamany catchments are "functional at risk" for this metric. The north eastern red catchment in Libby Creek is not accurate because field review found there to only be one stream in the catchment and there are no road crossings. This one catchment should be disregarded.

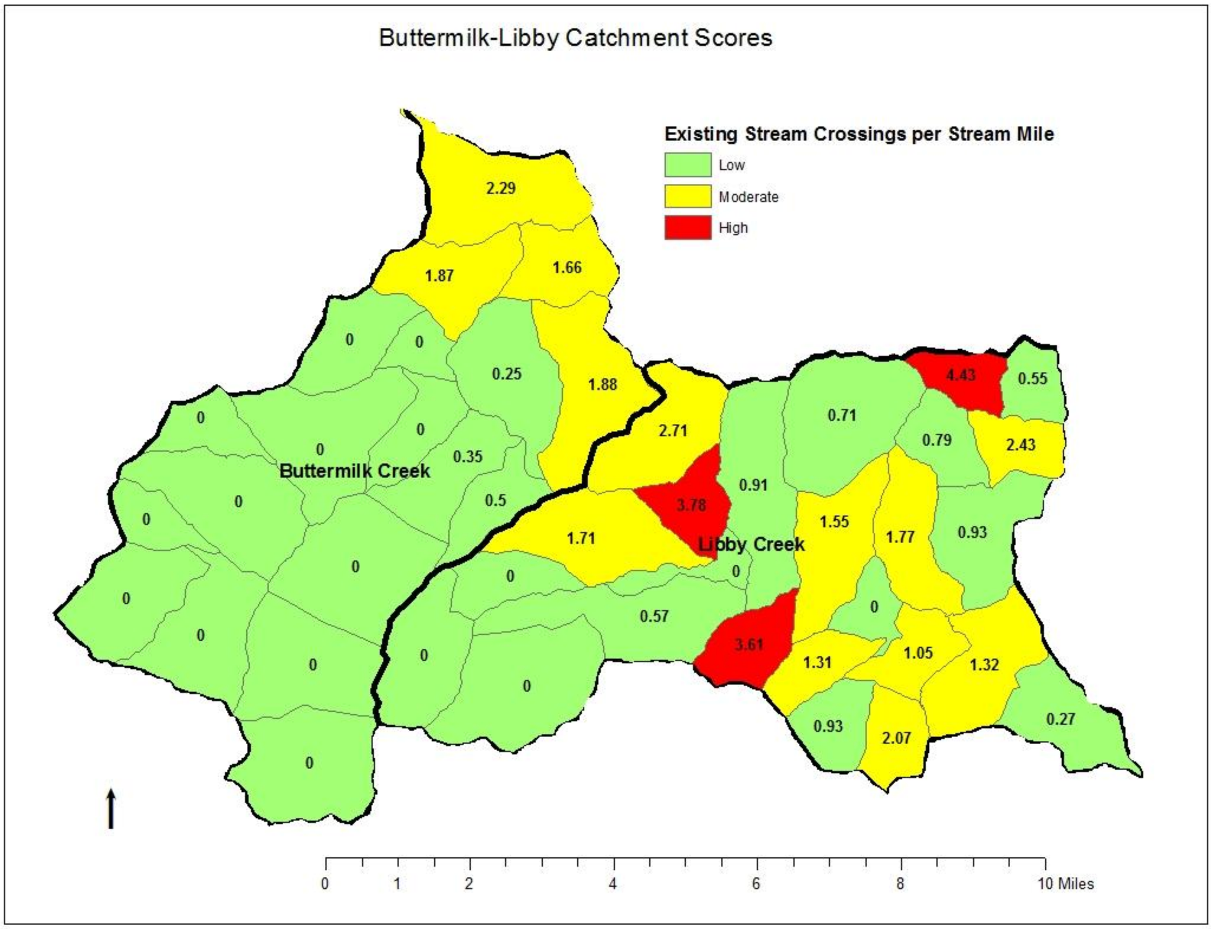

Figure 18. Existing number of stream crossings per mile of stream across Mission Project area catchments.

Resource Indicator: Groundcover

Surface rock fragments, vegetation recovery, timing/duration of precipitation, and slope gradient can either limit hydrologic processes linked with erosion risk or accelerate the erosion risk. Soils are sensitive to ground disturbance and displacement from harvest and prescribed fire activities. Soil erosion occurs mainly on disturbed sites where bare soil conditions exist and where vegetation has been removed and has not yet become reestablished. The greatest source of soil erosion within the analysis area is associated with roads where bare soil conditions exist on both cut and fill slopes and on the steeper road grades. Some soil erosion is occurring on the more heavily used cattle trails where continued bare soil conditions are occurring. Past riparian harvest have compacted soils which limits water infiltration rates. This has increased the rate of overland flow and subsequent increases in stream sediment delivery.

Site features like rock fragments and groundcover are essential for reducing the displacement of soil particles from rain splash erosion, improving infiltration rates, and trapping and filtering sediment. Field reviews identified vegetation within some of the RRs has been treated in the past. Levels of groundcover within the RRs were observed to be effective at trapping and filtering sediment.Areas of trailing, compaction, and bare soil are present where livestock have access to streams. Cover consisted primarily of grass, forb vegetation, shrubs and needle cast/litter.

Resource Indicator: Beaver Habitat

Past hunting and trapping has substantially reduced the beaver populations in the Mission Project area. The numberof beavers in the project area is unknown, but substantially below what is desired. Historically there were multiple sites throughout the project area.

Resource Indicator: Stream Channel Complexity

Level II stream surveys inventoried coarse wood levels in the project area in 2010 and 2011 (USDA 2010 and 2011). Three size classes of wood were measured, which are as follows:

- small, > 6” diam and >20’ long
- medium, >12” diam and >35’ long
- large, >20” diam and >35’ long.

Total wood numbers ranged from 44.6 to 221.2 pieces per mile that were 6inch diameter and greater. Key log numbers ranged from 0.7 to 9.7 pieces per mile. The main stem Buttermilk Creek, WF Buttermilk Creek, Black Pine Creek, Libby Creek, and NF Libby Creek were identified as having reaches with coarse wood levels below desired levels. Reduced wood levels limit channel complexity.

Resource Indicator: Fish Distribution

Fish inventory surveys identified current fish distribution in the project area. The culvert inventory also identified barrier culverts on fish bearing streams and fishless streams that have suitable habitat conditions. Eight barrier culverts exist in the project area that are blocking or partially blocking fish passage to about 5.6 miles of habitat.

Other Road Assessments

Using Geographical Information System tools (GIS) the project estimated 109 stream crossings in the project area.47 crossings are open to vehicle traffic and have approaches greater than 3 percent. These crossings present risks for vehicle traffic caused sediment delivery.

Environmental Consequences

Potential effects of three alternatives are analyzed and compared in terms of how project treatments (timber harvest, roads, fuels, stream channel restoration, and riparian improvement) affect water quality, riparian function and channel morphology, and watershed condition.

Alternative 1 – No Action

The No Action alternative would result in no short-term resource impacts such as increased sediment, surface erosion, and decreased water quality because no additional area would be disturbed by harvest, fuels, and road work.There would be no long-term benefits from restoration of currently compacted areas or reduced risk of high severity fire due to fuel reduction treatments.

ESA fish habitat would remain in a ‘functioning at risk’ condition, limiting local fish survival and reproduction. Habitat elements like fine sediment levels, fish access, and low wood levels would continue to limit spawning and rearing stages.Excessive chronic sediment delivery from riparian roads would continue, degrading spawning and rearing habitat. Existing sediment levels have shown to limit embryo survival, which limits fish survival (Bjornn and Reiser 1991).Habitat complexity related to wood levels would improve over time, but at a slow rate. Natural wood recruitment would occur slowly as live trees mature and die or disturbances push live trees over. Adding to the slow rate of improvement is the presence of younger, mid-seral riparian forests that will not provide full wood recruitment for decades. Nearly six miles of suitable habitat would be limited or have no access to fishreducing where and the amount of spawning and rearing can take pace. Low base flows from irrigation loss would remain limiting habitat quality and increasing competition for space and food. Important life stages like spawning and rearing for steelhead, bull trout, and chinook would continue to be depressed due to undesirable habitat conditions. Current depressed fish production would continue and the area would not contribute to the recovery of at risk fish species listed on the ESA.

Resource indicators and measures for the no action alternative (existing condition), at the sub-watershed scale, are summarized in Figure 19 below.

Figure 19. Resource indicators for the no action alternative.

Resource Element	Measure	No Action (Buttermilk)	No Action (Libby)
Water	Road Density	1.3 mi/mi^2	2.1 mi/mi^2

quality	Road drainage network increase (artificial streams)	20%	40%
	Riparian road density	1.4 mi/mi^2	4.0 mi/mi^2
	Road -stream crossing density	0.5 crossings/mi	1.2 crossing/mi
	Ground cover	Same as existing	Same as existing
Water quantity	Number of beaver release sites	0	0
Aquatic Habitat	Miles of stream channel restored	0	0
	Number of AOPs	0	0
	Miles of stream accessible to fish	0	0

Resource Indicator: Road Density

Under the no action alternative no road changes would occur and the effects to water resources would be adverse, long-term, and moderateCurrent road densities would continue to be functioning at risk with higher densities in localized catchments. The 13 catchments with high road density and 11 with moderate road density would remain. Hydrologic and ecological effects of roads discussed in the existing condition section of this report would continue. Roads in unstable condition would continue to deteriorateand sediment delivery will continue to occur. There would be no improvement of roads except those that occur under regular road maintenance which is consistently decreasing over the years.

Resource Indicator: Road Drainage Network Increase

Roads will continue to artificially increase the drainage network at the same level. In the Buttermilk drainage, the overall increase is moderate at ~20% and four catchments currently are considered high and two are moderate. The catchments with high and moderate drainage increase would continue to move water out the systemat an increased rate. There would be some increase in the magnitude and frequency of peak flows. Most of Buttermilk is roadless and has little or no increase in drainage network. Libby Creek has substantially higher road mileage. Existing road drainage network increase is estimated at 40% with thirteen catchments with high road drainage network increase and eight with moderate increase. These rankings suggest there is substantial hydrologic connectivity between the roads and the stream network. With no action, the effects to water resources would likely be adverse, long-term, and moderate. With 40% more stream connectivity in the drainage, the flow regime is departed from historic conditions. Peak flows are increasedcompared to historic conditions, which can have negative consequences to spawning and redd incubation from sediment transport.

Resource Indicator: Riparian Road Density

Where riparian road densities are high,degraded stream conditions will remain. Riparian road density is low in the Buttermilk sub-watershed which is consistent with the low fine sediment.

The effects from no action in the Buttermilk Creek sub-watershed would be adverse, long-term, and minor. Libby has a moderate level of sub-watershed road density but the riparian road density is high. This indicates many of the roads in the sub-watershed are within 300 feet of streams, where high road-stream interactions occur. Elevated stream sediment levels in Libby Creek are likely due to riparian roads and their lack of maintenance. The effects from no action in Libby Creek sub-watershed would be adverse, long-term, and moderate. The current sediment delivery from riparian roads would continue and spawning habitat would remain in an at risk state. This alternative would not address the water quality indicator for high fine sediment levels from road impacts.

Resource Indicator: Road-stream Crossing Density

The current number of stream crossing across the project area would remain. Catchments in lower Buttermilk and across Libby would have moderate to high density of stream crossings that would continue to be sources of chronic sediment delivery, and would likely cause adverse, long-term, and moderate effects to water resources. Fine sediment levels in Libby Creek would remain elevated and ESA fish habitat quality would continue to limit fish production.

Other Road Treatments

Restorative road treatments like replacing undersized stream culverts, rock-armoring open roads, and constructing fords on small streams would not occur. Undersized pipes have a high risk of getting plugged and failing or diverting the stream channel.

Water quality as related to sediment associated with roads was identified as a limiting factor in fish production for ESA listed species. This alternative would not address road-stream impacts that are degrading spawning habitat and contributing to the at-risk status of steelhead, bull trout, and chinook.

Resource Indicator: Ground Cover

Groundcover within the RRs and upper watersheds would remain at existing levels. Levels of groundcover within the RRs were observed to be effective at trapping and filtering sediment under existing conditions where vegetation and topography exclude livestock. No action would have beneficial, long-term, and negligible effects to riparian cover and water resources.

Cover consisted primarily of grass, forb vegetation, shrubs, and needle cast/litter. The majority of bare soil within the project area is related to road surface area.

Resource Indicator: Beaver Habitat

Current beaver colonies in the project area are well below historic levels. Wetlands associated with beavers act as natural water storage features on the landscape that supplement summer and fall base flows. Irrigation and domestic water withdrawals will continue in Buttermilk and Libby Creek that reduce summer and fall flows. At-risk species in the project area will continue to have reduced habitat, lower quality refugia from warm water and predators, and higher competition for space during summer and fall months.

Water quantity is a limiting factor for the Buttermilk and Libby Creek drainages due to water withdrawals. This alternative would likely lead to adverse, long-term, and minor effects to water storage and water resources. This alternative would do nothing to address this important indicator and would not contribute to the recovery of at-risk fish species.

Resource Indicator: Stream Channel Complexity

Important spawning and rearing reaches in the project area will remain below desired conditions for the stream complexity indicator. Natural wood accumulation is occurring and some active wood recruitment is happening; however, large wood availability, recruitment, and retention have been altered over time. No action would likely cause adverse, long-term, and minor effects to instream fish habitat.Instream wood levels in certainreachesare well below desired wood loading for complex, high quality fish habitat. The underlying processes that lead to natural wood recruitment will take many decades or centuries (e.g. growth of large trees and more natural wood recruitment rates)(Shull and Butler 2014).Survival and population abundance for at-risk ESA species will continue to be limited in the Buttermilk Creek and Libby Creek drainages.

Resource Indicator: Fish Distribution

~Six miles of suitable fish habitat would remain fragmented with partial or no access.No action would lead to adverse, long-term, and moderate effects to fish populations due to the vulnerability of isolated populations. Within drainage migrations are important for juvenile and adult fish to find refugia from warmer temperatures and predators, find feeding areas and to have reproductive success. Habitat connectivity is important for resilience from natural disturbances and will be increasingly important with anticipated changes in climate. Preventing full habitat access to suitable habitat limits localized fish production and hinders recovery efforts for at-risk fish species.

Conclusion

Alternative 1 (No Action) would have no direct impacts to water quality, fish habitat, and individual fish species. However, the existing road network would continue to contribute excessive fine sediment levels that would maintain high fine sediment levels in Libby Creek. Fish habitat complexity would continue to improve naturally, but at a pace that could take decades before suitable habitat conditions exist. Low base flows would continue to be a limiting factor that reduces fish production. Fish barriers would remain, preventing full habitat access and maximum fish production. In the long-term, taking no action would maintain current at-risk hydrologic processes and aquatic habitat conditions that would impede recovery of ESA listed fish species.

Alternative 2 – Proposed Action

The proposed action includes 1,952 acres of commercialharvest, 8,303 acres of non-commercial thinning (pre-commercial and ladder fuel reduction treatments), 7,363 acres of under burning, a suite of road treatments, and measures to improve stream channel, stream flow, and riparian function.Figure 20 displays the changes to hydrologic and aquatic indicators.

Most treatments under Alternative 2 are proposed under Alternative 3. Most effects are common to both. Alternative 3 has different transportation plan that prioritizes reducing ecological risks associated with aquatic and wildlife resources along with providing a safe transportation system for managing the landscape and public use. Alternative 3 has additional road decommissioning, closures, rocking open road-stream crossings, and converting a few small stream crossings to hardened fords.

Project Design Features and Mitigation Measures

The Hydrologic/Aquatic Design Features and Mitigation Measures were developed to lessen impacts from proposed actions, provide for meeting Okanogan Forest Plan and Northwest Forest Plan Standard and Guidelines, and to meet resource objectives.Measures include working in fish habitat during the Washington State designated instream work windows, maintaining protective no-treatment buffers along streams and wetlands during harvest activities, isolating the work area fish during culvert upgrades, removing all fish from the work area prior to work in occupied habitat, and using standard erosion control BMPs. Appendix Adisplays each of the protective hydrology, aquatic, and riparian measures for this project.

Effects

Figure 20: Resource Indicators and Measures for Alternative 2

Resource Element	Resource Indicator	Measure	Alt 2 (% Change)
Water Quality (Sediment)	Catchment Road Density	Number of Catchment Rankings Lowered	5 (3 High to Moderate, 2 Moderate to Low)
	Road Drainage Network Increase	Number of Catchment Rankings Lowered	5 (2 High to Moderate, 3 Moderate to Low)
	Riparian Road Density	Number of Catchment Rankings Lowered	8 (4 High to Moderate, 4 Moderate to Low)*
	Road-stream Crossing Density	Number of Catchment Rankings Lowered	6 (1 High to Low, 1 High to Moderate, 4 Moderate to Low)
	Ground Cover	Amount of bare soil	+105 acres
Water Quantity (Base Flow)	Beaver Habitat	Number of beaver release sites	8 sites
Aquatic Habitat	Stream Channel Complexity	Miles of stream	8.3 miles
	Fish Distribution	Miles of accessible habitat increased	5.6 miles
		Number of aquatic passage pipes installed	8 AOPs

* Changes in catchment rankings listed are for the averaged catchment road density and riparian road density, showing where riparian road density coordinated with catchment density, which is a more meaningful metric.

Resource Indicator: Road Density

~Thirty-five miles of roads would be decommissioned.Riparian road decommissioning would be prioritized. At the sub-watershed scale, road density would decrease from 1.3 mi/mi^2 to 1.1 mi/mi^2 in Buttermilk and 2.1 mi/mi^2 to 1.5 mi/mi^2, whichare18 and 28% reductions.About 35 miles of roads would also be hydrologically closed across the project area. Putting roads in hydrologic storage may include removing stream crossings, constructing water bars, and surface scarification. Reducing road density and hydrologically closing roadswithin RRs reduces road-stream interactionsand sediment delivery to channels.

Road density would decrease in most catchments across the project area. The number of moderate and high road density catchments would drop in ranking as well.Figure 21 displays catchment road density under Alternative 2.In Buttermilk, the number of catchments with a high ranking would stay the same and the moderate density catchments would decrease by one. This would not altersediment delivery rates from roads measurably. In Libby sub-watershed, two catchments would move from highto moderate density and one moderatewould move to low road density. Sediment levels in this sub-watershed are elevated and this alternative would reduce sources of sediment delivery where road-stream interactions occur.

Road density would decrease at the sub-watershed scale and within some key areas in Libby Creek. Chronic sediment delivery would decrease across the project area with the greatest reduction in Libby Creek. The amount of riparian roads removed would result in a long-term, negligible beneficial effect in Buttermilk and minor beneficial effect in Libby.

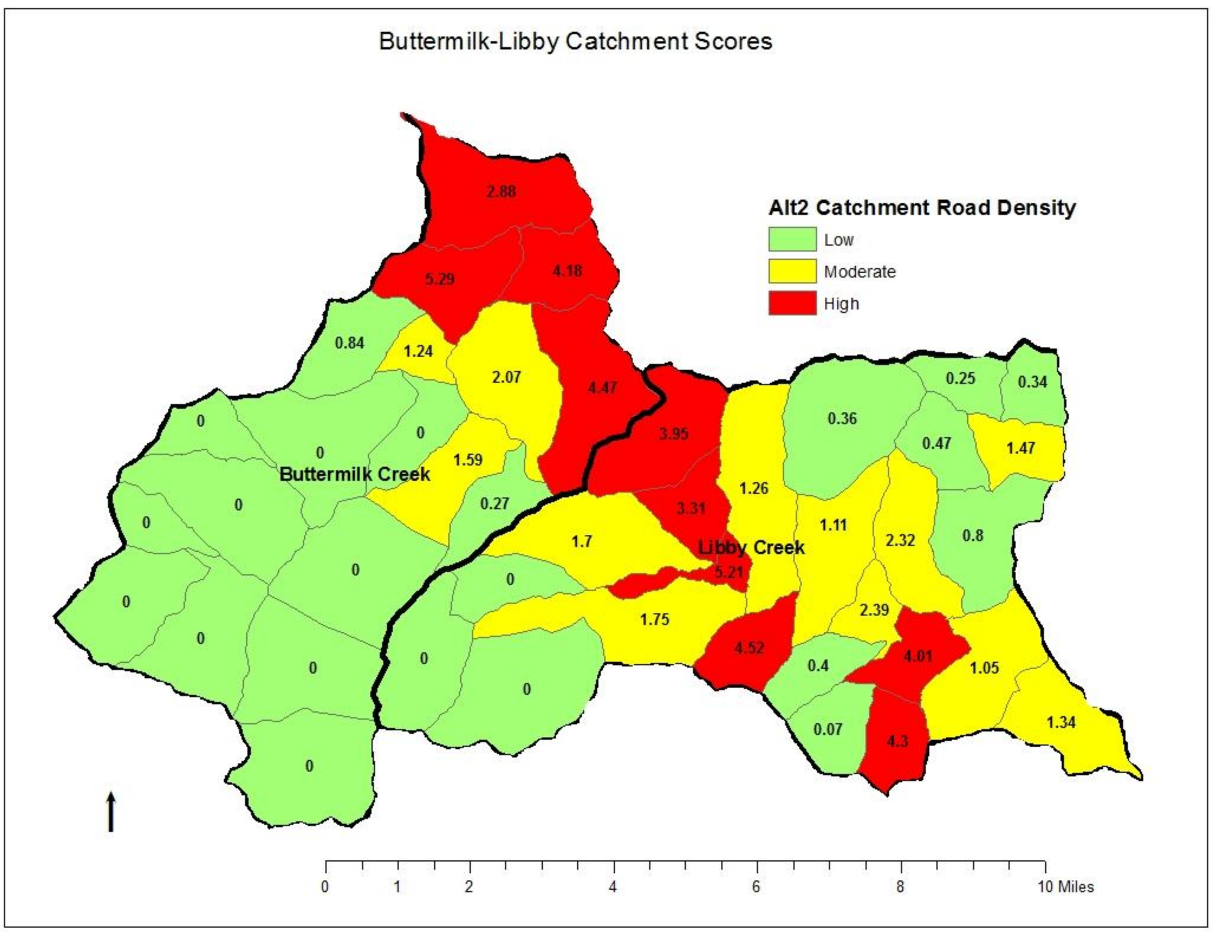

Figure 21: Alternative 2 road density across the Mission Project catchments.

Resource Indicator: Increase in road drainage network

The road drainage network would decrease by about 30%across the project area. At the sub-watershed scale, Buttermilk decreased by 15% and Libby by 35%. A reduction in the road drainage network will improve watershed condition and move the system towards a more natural flow regime.

Figure 22 displays catchment road drainage network under Alternative 2. No catchment rankings would change in the Buttermilk sub-watershed. The small improvement in Buttermilk is not expected to result in a measurable change in stream flow. In Libby, five catchments would be improved. We would expect slight improvement to peak flow frequency, magnitude and a small improvement to base flow.Libby and Buttermilk are expected to have a long-term, negligible, beneficial effects on peak and base flows.

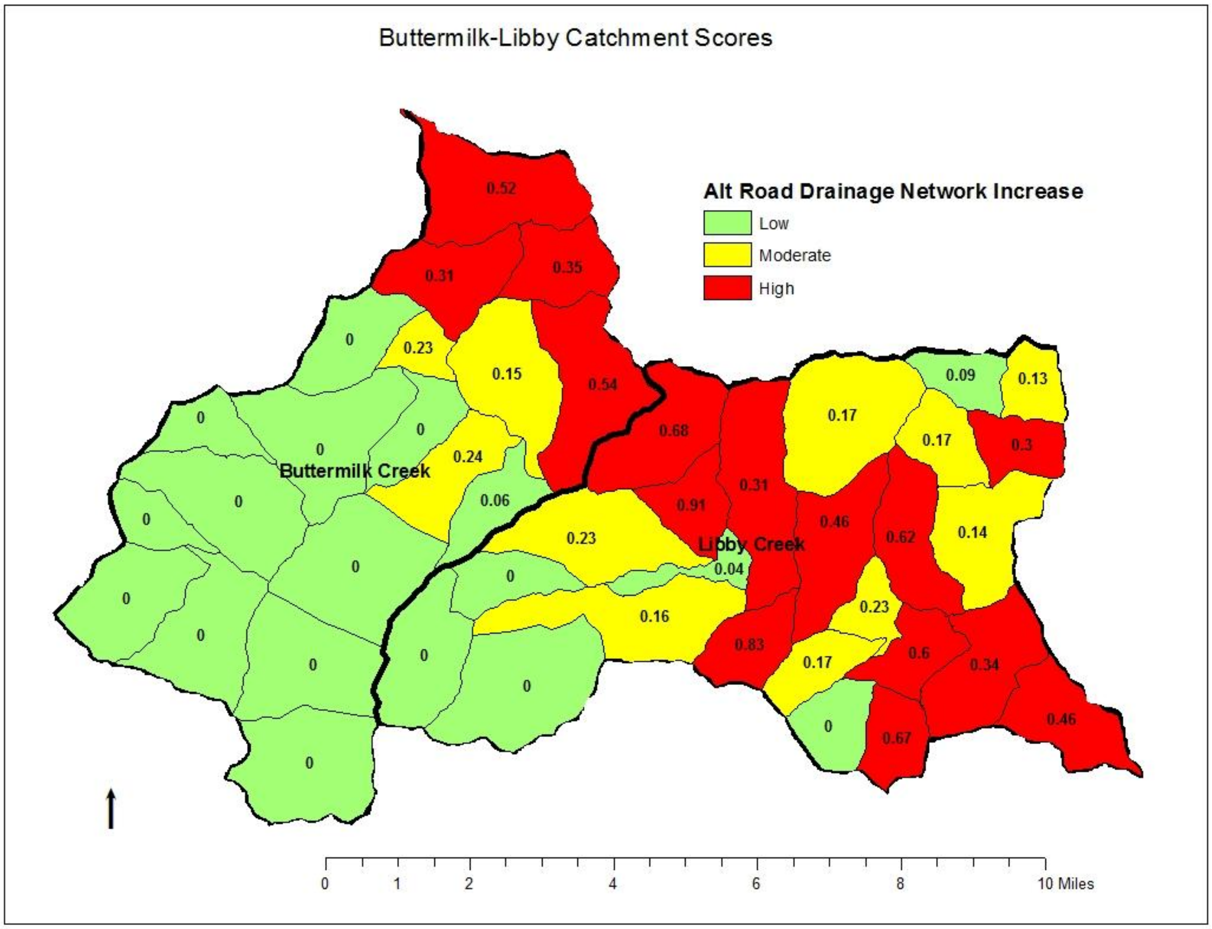

Figure 22: Increase in drainage network from the road system across Mission Project catchments.

Resource Indicator: Riparian Road Density

Riparian road density would decrease by about 35%in the Libby and 17% in Buttermilk sub-watersheds. At the catchment scale, riparian road density rankings in Buttermilk would not changewhile nine catchments in Libby would drop in density rankings, indicating an improvement for reducing road-stream interactions (Figure 23).

In the averaged catchment/riparian road density rankings, riparian road density would decrease in key areas around NF and SF Libby, Ben Canyon, and Hornet Draw Creeks (Figure 24). Catchment road density is moderate to high in these areas andreducing riparian road density would improve road-stream interactions.

A reduction in riparian roads to lead to improved watershed condition. As roads are rehabilitated vegetation would re-establish that provides improved wood recruitment and prevents surface erosion. The current road mileage in Buttermilk sub-watershed is low and the small reduction in roads would have a long-term negligible beneficial effect. Libby has more proposed road decommissioning and this will result in a greater beneficial effect. The projected beneficial long-term effect would only be a minor improvement over existing road conditions. Several riparian roads will remain that will continue to contribute to altered hydrologic function.

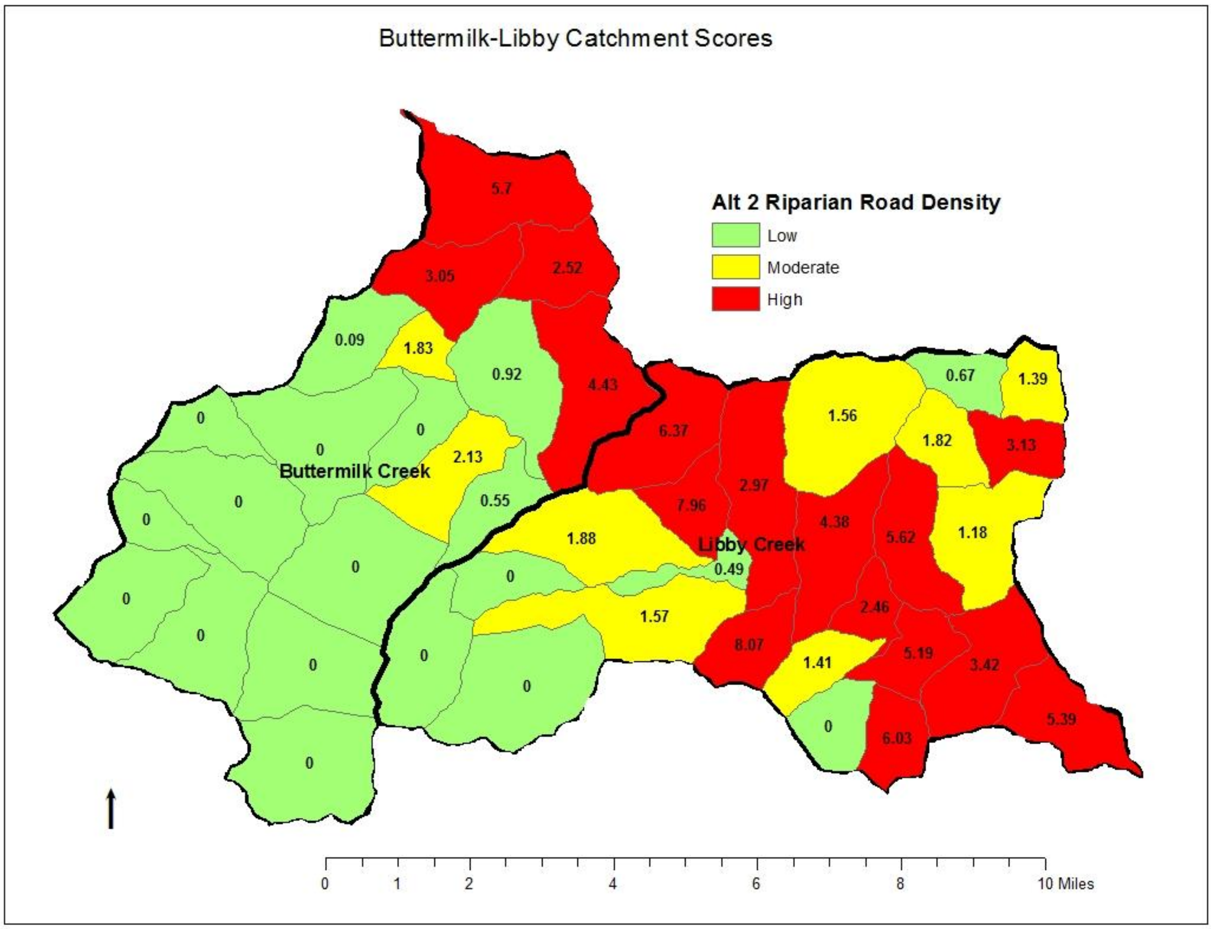

Figure 23:Alternative 2 riparian road density across Mission Project catchments.

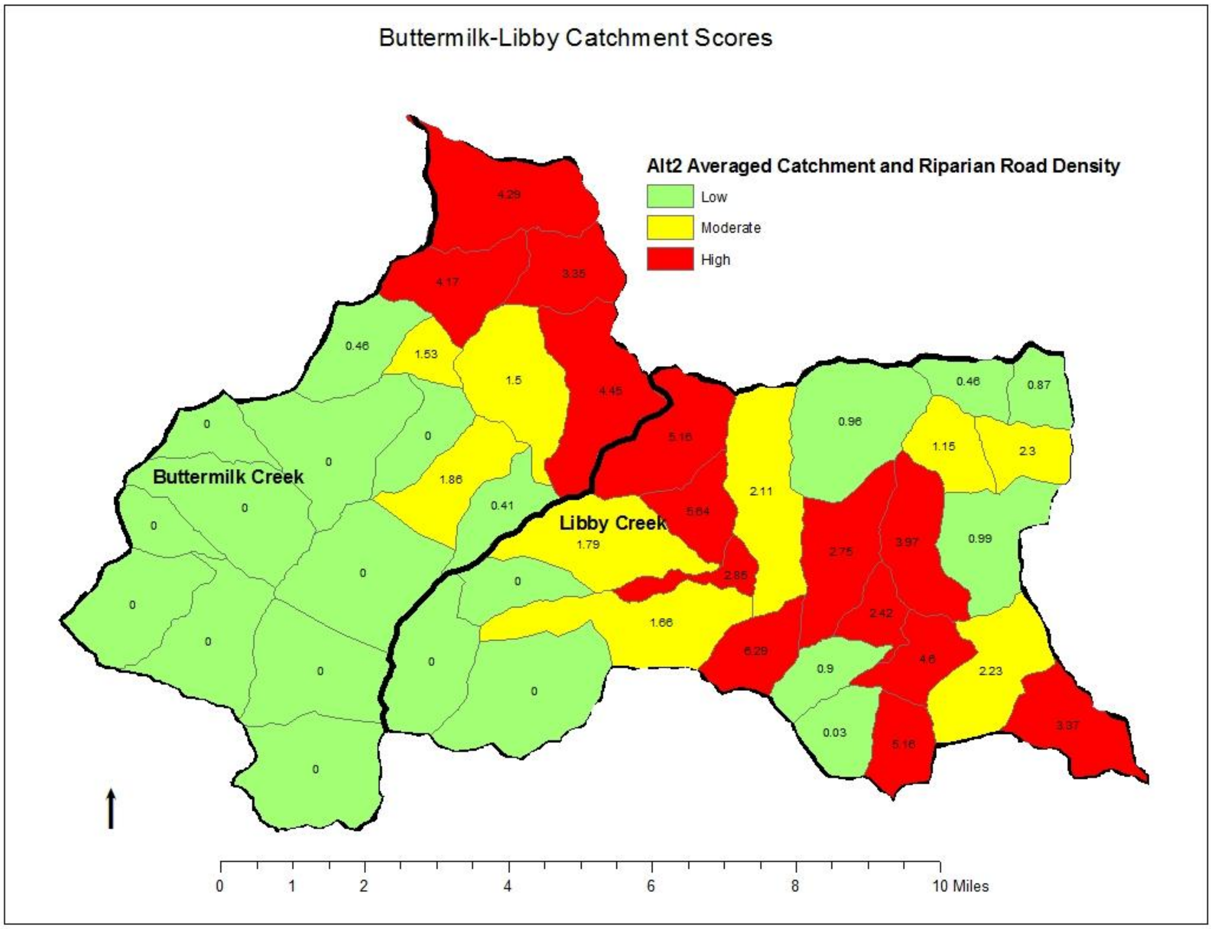

Figure 24: Alternative 2 averaged catchment and riparian road density across Mission Project catchments.

Resource Indicator: Stream Crossings per Mile

Alternative 2 would remove up to 40 stream/draw crossings across the project area that includes 6 perennial streams, 23 intermittent streams, and 11 ephemeral draws. Stream crossings per mile density would decrease by about 32% across the project area (Buttermilk ~13% and Libby ~38%).

Reductions in catchment ratings would occur in both sub-watersheds (Figure 25). Changes in Buttermilk would be minor. One catchment in Buttermilk would go from moderate to low ranking. Libby sub-watershed would have five catchments move to lower ranking levels. Two catchments would go from high to moderate and three moderate catchments would go to a low ranking. Road-stream crossings are the points where most road sediment reaches streams and removing crossings would eliminate sediment delivery sources. Buttermilk would see a slight reduction in sediment sources while Libby would see a greater reduction in sediment sources. The change in stream crossing density would result in a negligible beneficial long-term effect in the Buttermilk sub-watershed and a minor to moderate beneficial long-term effect in the Libby sub-watershed.

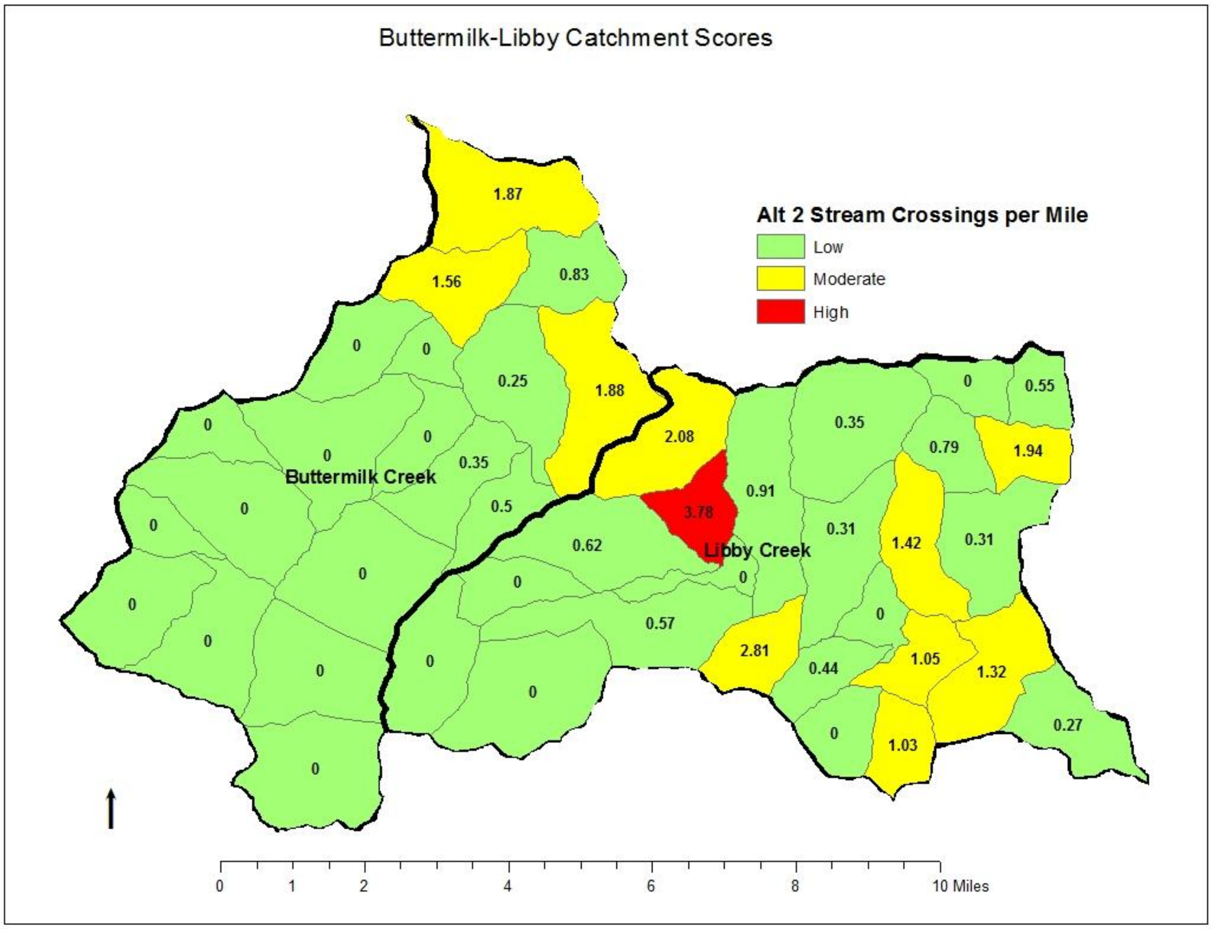

Figure 25: Alternative 2 number of stream crossings per mile of stream across Mission Project area catchments.

Resource Indicator: Ground Cover

Each treatment activity is associated with a different level of groundcover alteration within the project area. Alteration or removal of groundcover in drainages increases the potential for erosion and sedimentation by reducing the effectiveness of groundcover to trap and filter sediment from upslope areas. There may be short-term increases in fine sediment delivery to streams.

Vertical change of canopy cover occurs with timber harvest. Temporary roads, skid trails, landings, machine piles, hand piles, and areas of high severity burning (small portions of underburn units) are areas where groundcover would be temporarily removed exposing bare soil surface during harvest and prescribed burning activities. Most of these activities are proposed outside of RRs and at a distance away from streams and wetlands. Impacts are discussed in terms of changes to groundcover and sediment production within the RRs and ephemeral drainages and the efficacy of riparian buffers to trap and filter sediment.

There would be an increase of ~102 acres of bare soil created by proposed activities. There is an additional ~3 acres of bare soil created by temporary roads. BMPs and temp road locations will minimize the delivery of sediment to any stream channels (no new stream crossings and avoiding RRs). Temporary roads will also be decommissioned after treatment.

Proposed reductions in effective groundcover in RRs have been avoided, minimized, and mitigated by project design to limit bare soil creation near surface water areas. Harvest and fuels activities are designed to maintain effective groundcover and utilize existing roads, skid trails, and landings to minimize the creation of more disturbed soil. ~272 acres (8 acres bare soil) of under burning would occur in RRs.Design criteria and objectives of low to moderate fire behavior, short-term fine sediment generation potential is low. This should not substantially impact riparian buffer efficacy and sediment delivery to streams should be minimal from treatment units. There should not be any measurable increase in fine sediment from the proposed treatments. The vast majority of fines are being delivered annually by the road system (see roads section above). Thinning, harvest activities, and fuels treatments should generate no measurable increase in sediment yield due to buffers and other design criteria. In addition the fuels treatments will not occur in the same year. These values are total values only and do not address implementation schedule.

The increase in bare soil would be temporary and would revegetate, but the duration would be long-term as defined under Impact Framework and Duration Definitions. Revegetation would likely take one to three years before created bare soil areas re-establish vegetation to effectively cover exposed soil and prevent surface erosion. Areas with created bare soil would be dispersed across the project area and only a small proportion would occur within RRs (< 0.3%). The increase in bare soil would result in negligible adverse long-term impact to the indicator and stream sediment levels.

Resource Indicator: Beaver Habitat

Beavers develop wetland and floodplain habitat that create natural water storage in watersheds. Alternative 2 proposes to release beaver at two sites in the Buttermilk sub-watershed and six sites in the Libby sub-watershed. Natural wood posts and brush would be installed at six of the sites to encourage establishment. Short-term impacts would be increases in turbidity where posts are installed. In the long-term, the beavers could increase natural water storage that would increase base flows during the summer and fall months. Increased base flows would improve rearing habitat for juveniles and holding habitat for adult fish.

The increase in beaver habitat would improve water storage and sustain higher flows during low flow periods for long-term, potentially persisting for years. Pollock et al. (2003) describes how a small number of beaver dams can augment low flows during the summer. At the site scale, the improvement in low flows below the release sites would be moderate. At the sub-watershed scale, the level of benefit would be small and would be a minor magnitude effect over the long-term.

Resource Indicator: Stream Channel Complexity

In this alternative, small to large diameter trees would be hand felled on eight miles of fish streams the project area. This would moveimportant spawning and rearing streams towardsdesired coarse wood quantities. The intent of the project is to createa temporary improvementin existing conditions to allow more time for natural coarse wood recruitment.This will bringgeomorphological processes in project area streams towards desired stream channel complexity.

The increase in stream complexity would improve a substantial portion of spawning and rearing habitat in the project area and would lead to beneficial long-term moderate effects to habitatAdding trees to the proposed reaches would result in a moderate beneficial effect to fish habitat quality.

Resource Indicator: Fish Distribution

Fish access is important to achieve optimal spawning and rearing activities and is impaired in the project area by culvert barriers. Restoring fish access is a cost effective way to boost fish production. Restoring passage at eight sites in the project area would allow fish access to about six miles of quality spawning and rearing habitat. There would be short-term sediment impacts. BMPs would minimize impacts to minor levels. In the long-term, more fish habitat would be available for spawning and rearing. Fish production in these areas should increase overall production at the sub-watershed scale. This would contribute directly to the recovery of at-risk ESA fish species. The increase in fish access would have a moderate beneficial long-term effect to local fish distribution and fish production.

Resource Element: Sediment Summary

Vegetation Treatments

The project proposes 1,952 acres of commercial harvest and 2,072 acres of non-commercial understory treatments. Harvest methods include1,832 acres ground based harvest, 75 acres of cable yarding, and 44 acres of combination ground based and cable. Log landings are estimated at one landing per 10 acres of commercial harvest(~195 landings). The soils report predicts harvest activities will create about ~220 acres of disturbed soils and ~51 acres of bare soil. Pre-commercial thinning, tree girdling, and ladder fuel thinning would be done by hand with no bare soil created. These actions would have no impact to stream sediment levels.

To minimize soil disturbance during and after harvest activities, a suite of design features are proposed. Theseinclude doing some harvest during winter over frozen ground, using slash mats of vegetation on skid trails during summer harvest, decompacting and planting landings, putting water bars and woody debris on skid trails where soil disturbance is high, and other measures described in the Soils Report.

Winter harvest is proposed on 600 acres of the proposed harvest area within RRs. To minimize sediment impacts, wood cutting and removal in these acres would occur winter conditions when the ground is frozen. The other 1,276 acres occurs on soils that are not identified as sensitive and yarding will be done over a slash mat using a harvester and forwarders, which leave branches on the skid trails that distributes the weight of the machines and minimizes soil rutting and soil compaction (Eliasson and Wasterlund 2007).

Commercial harvest proposed within RRs has two resource objectives. The first objective is to open up riparian areas in drier sites within Libby Creek to allow for more hardwood generation that would attract beavers.This will be in coordination with beaver release areas to improve water storage and lessen direct evapotranspiration. The second objective is to maintain and restore the species composition, structural diversity, and natural disturbance patterns of plant communities found within RRs.Past management activities have altered the stand structures and natural disturbance patterns of forest vegetation in the analysis area RRs. Fire exclusion and timber harvest have altered tree species composition, tree stocking levels, and size class distribution of RR forest stands, especially in the dry forest zones. Shade tolerant Douglas-fir forest cover has expanded, tree stocking levels have increased, and average tree size has decreased throughout RRs in response to these management practices. Large trees currently are less common compared to historic levels and tree stocking levels are sufficiently high in many RR stands that hinder development of large tree structure for wildlife habitat, stream shade, and future in-stream wood.

About 78 acres of commercial harvest is proposed in the outer edge of RRs. All RR harvest activities have the objective of moving riparian habitat conditions towards meeting management objectives for water temperature, sediment regime, large woody debris, and bank stability. The Northwest Forest Plan allows for treating within RRs in circumstances where you have undesirable riparian forest conditions that would move conditions towards attaining ACS Objectives (Northwest Forest Plan Standard and Guide TM-1c on page C-31-32).

Commercial harvest designed to improve vegetation conditions within RRs can also result in short-term negative impacts to streams. A common approach to mitigate effects from logging on instream habitat and biotic communities is to protect a portion of the riparian area with buffer strips. Minimum protective buffer widths are suggested from various studies or management guidance to maintain important stream attributes like water temperature, wood recruitment, and sediment levels (FEMAT 1993, Rashin et al. 2006, Sweeney et al. 2014). The following discussion illustrates how internal buffers were applied within the RR treatments to prevent or substantially reduce short-term impacts to ESA listed fish and to RMOs.

In order to meet ACS Objectives, stream buffers would be used to filter sediment, provide shade, maintain existing wood recruitment along fish bearing streams and ~(>70%) along intermittent streams, and help retain microclimate conditions. Important factors considered that influence sediment transport distances were infiltration rates, hillslope gradient, and surface roughness. Figure 26displays the prescribed stream buffer widths that were developed for the project following multiple field trips with the ID Team, the project fish biologist, and project hydrologist and are based on site conditions and literature review (Rashin et al. 2006; Liquori et al. 2008). Along perennial streams, the buffer width would be at least 100ft, consistent with FEMAT guidance (p. V-28,29;1993) to maintain shade. Along intermittent channels, the project would employ a variable buffer width based on adjacent valley slopes and the presence of inner gorge features. Minimum buffers widths would be >50 feet when slopes are 15% or less and 75 feet with slopes 16-25%. Slopes exceeding 25% would receive full 100-foot buffers.

Figure 26: No-treatment buffer widths along streams.

Riparian Harvest Buffers		
Stream Type	**Buffer Width**	**Adjacent Slopes**
Intermittent channels*	≥ 50ft or inner gorge**	0-10%

	≥ 70ft or inner gorge	11-25%
	≥ 90ft or inner gorge	26-35%
Perennial Non-fish	≥ 100ft	< 35%
Perennial Fish	≥ 100ft	< 35%

*units where commercial harvest occurs closer than 100 feet from streams would occur during winter.
*slopes breaks where gradient is >35%.

Specific design criteria described inAppendixA were developed to ensure that Forest Plan and ACS objectives are met.About 60 percent of the harvest in RRs would occur over frozen ground which would mitigate harvest related impacts to surface erosion and sediment production on these acres. Winter logging on frozen soils has shown to significantly reduce the amount of soil disturbance compared to summer harvest (Page-Dumroese et al. 2006, Reeves et al. 2011). Field review on previous projects on the Methow Valley Ranger District observed little to no surface erosion following winter harvest activities. The other 40 percent would be optional summer or winter harvest and the stream buffer would be at least 100 feet. The light impacts of winter harvest and the no-treatment buffers minimize sediment transport. No effects are expected to occur in streams. Figure 27 defines the season of harvest for the different treatments and by sub-watershed.

Figure 27: Commercial harvest in RRs by season.

Commercial Harvest Treatment	Buttermilk	Libby		Grand Total
	Summer/Winter	Summer/Winter	Winter Only	
Aspen	13	7		20
DFDMT	1	0		1
DFR	5	6	44	55
MFT	0		2	2
PP	0	0		0
Grand Total	19	13	46	78

The use of no-harvest buffers is a proven technique to limit or prevent sediment deliver to streams. Rashin et al. (2006) studied the effectiveness of forested buffer strips at preventing erosional features associated with harvest operations from delivering depositional sediment to adjacent stream channels. In their study, they reviewed 26 forested logging operations across WA State that included some sites on the eastern slopes of the Cascade Mountains. They observed the primary operational factors that influenced sediment delivery (coarse fines) to streams were the proximity of timber falling and yarding activities to streams, valley side-slope gradient, and the presence or absence of designated stream buffers. Rashin found that erosion from harvest activities closer than 30 feet of streams would generally produce and deliver sediment to streams. Outside of 30 feet, sediment delivery rates drop rapidly with increasing distance to the channel. Rashin concluded that harvest and yarding setbacks of 10m (30ft) could be expected to prevent 95% of depositional sediment delivery to streams from harvest-related erosion features, supporting the value of the prescribed buffers. Factors that aid in the buffer effectiveness are the amount of forest ground cover and soil infiltration, which can limit sediment transport distances. Rashin's study did not look at suspended sediment and he said their prescribed buffer width may not trap suspended sediment (Rashin personal communication 2014). Sweeney et al. (2014), whichdid consider suspended sediment, suggests 30 meter (98ft) buffers are necessary to trap ultra-fine sediment from reaching streams. The prescribed protection buffers of at least 100 feet for optional summer harvest units and winter harvest using the buffers defined in Figure 26, it is unlikely any sediment would reach adjacent streams from commercial harvest in RRs.

Non-commercial thinning that includes tree girdling, TSI, and LFR would not cause any bare soil. Therefore, these activities would not result in any sediment delivery to streams.

In summary, the vegetation treatments would have inconsequential effects to sediment delivery to streams and fish habitat. Due to the factors described above, this sediment delivery increase would not be measurable in downstream CH for steelhead, spring Chinook, or bull trout. Therefore, these actions would result in a negligible negative impact to instream fine sediment levels.

<u>Fuels Reduction Treatments</u>

Fuels reduction on 10,250 acres would reduce fuels and decrease the risk of potential high severity fire in the Buttermilk and Libby Creek sub-watersheds. High severity fire kills trees and decreases canopy cover, partially or completely burns ground cover, and may form water-repellant soils (hydrophobic) depending on burn intensity. Soil water storage, interception, and evapotranspiration are reduced when vegetation is removed or killed by fire and when organic matter on the soil surface is consumed by fire (DeBano et al. 1998; Neary et al 2005). Fire consumption of ground vegetation and hydrophobic soils increase overland flow and erosion and sedimentation risk. Burned areas are vulnerable to accelerated soil erosion which can increased post-fire sediment yield (Neary, et al., 2005). Increases in surface erosion following wildfire have been well documented (Helvey, 1980, Robichaud and Hungerford, 2000; Wondzell and King., 2003; and Neary et al., 2005); however effects are spatially variable based on soil condition, burn severity, and timing and magnitude of precipitation (Robichaud and Hungerford, 2000). Helvey et al. (1985) found that annual sediment yield increased as much as 180 times above pre-fire levels following a high-mortality wildfire in the Entiat experimental forest. Water yields and peak flows can also increase from large fires due to loss of canopy cover and reduction in evapotranspiration (Helvey 1980).

Prescribed fire is used as a management tool by itself or in conjunction with thinning to reduce fuel loading and the risk of uncharacteristically large fires (Mitchell et al. 2009). The most effective way to reduce fire severity is forest thinning in conjunction with prescribed burning (Covington et al. 1997, Graham et al. 1999). Most prescribed fires are ignited under conditions that limit the potential for high severity fires (Wondzell 2001), they have less of an effect on vegetative litter and soil organic structure, and result in a lower risk of erosion and changes in water yield and peak flows (DeBano et al. 1998).

Climate change is expected to alter fire return intervals as well as potential effects from increasingly large, severe fires. There is a close correlation with climate conditions and severity and extent of wildfires in the western U.S., and projected changes in temperatures and precipitation in the interior Pacific Northwest are expected to increase the risk of larger, more severe fires (Littell et al. 2010, Westerling et al. 2003).

Potential direct and indirect effects to hydrologic processes and water quality from non-commercial fuels treatments and prescribed fire are mitigated through BMPs and standards and guidelines.Theselimit fire intensity and severity, ground-disturbing activities (including firelines), and retain adequate groundcover. Fuels reduction treatments on 16% of the Buttermilk and 25% of the Libby sub-watersheds in the proposed action would increase landscape resiliency to large-scale wildland fire and would mitigate potential effects to hydrologic function and water quality.

The project hydrologist expects some sediment delivery to streams from the proposed fuels treatments. Following the design criteria of no active lighting within 25 feet of intermittent streams and 100 feet of perennial streams would limit the amount of created bare soil. Riparian under burning would have a resource objective of maintaining 95% survival of over story trees, 2/3s or 66% of the understory, and 50% of the ground cover. If these objectives cannot be met, the area would be excluded. During ignition, if these objectives are being exceeded, lighting would cease and conditions reassessed. Burning is not expected to remove the duff layer that would maintain a protective cover over bare, inorganic soils. During pile burning, protective buffers of 25 feet along intermittent streams and 50 feet along perennial streams would be used. These design criteria would limit bare soil production and potential sediment delivery.These actions would result in a negligible negative impact to instream fine sediment levels. In the long-term fuels would be reduced in the project area that would decrease the potential for high intensity wildfire. Forest fires, especially high severity ones, can lead to high soil erosion rates in the following years that tend to substantially increase stream sediment loading and compromise fish habitat.

<u>Harvest Related Road Use</u>

Log hauling would occur on 53 miles of road across the project area. Eighteen miles would be on closed roads opened to access harvest units. These roads vary in condition from drivable road surfacesto impassable vegetated surfaces. Closed roads would be bladed open. Four new temporary roads would be constructed. They are located outside RRs and sediment delivery to streams is of little to no concern. The other 31 miles would occur on open roads. Winter and summer log haul would disturb road surfaces and could result in some sediment delivery to streams.

Design criteria for log hauling would reduce sediment delivery to streams to insignificant magnitudes. Some examples include;

- Limiting log hauling to dry conditions
- Prohibiting hauling during rain events that result in road surface flows
- Placing crushed rock over perennial stream crossings

Hauling during dry conditions would reduce the potential for truck traffic causing surface erosion and sediment delivery. Rocking stream crossings has shown to substantially reduce sediment delivery to streams from vehicle traffic.

The project proposes to rock sevenperennial stream crossings on haul routes in the Libby Creek drainage prior to log haul. Rocking stream crossings is an effect strategy to reduce road surface erosion. Ward and Sieger (1983) observed to this treatment to reduce road surface erosion by 80%. Coe (2006) conducted a study of sediment production and delivery from unpaved forest roads and observed rocking the approaches to stream crossings and reducing the number of stream crossings are effective means for reducing road related erosion.

Rock armoring would provide an initial reduction in sediment delivery to Buttermilk and Libby Creeks. Road maintenance, opening closed roads and other roadwork would cause some increase in sediment delivery. Design details and mitigation measures will be implemented to minimize the effects to sediment delivery and water quality. The amount of sediment delivery reduction from armoring 7 stream crossings would exceed the temporary increases from the harvest related road activity resulting in a net reduction in road-related sediment input overall.The log hauling and other associated harvest related road work would not result in a net increase in fine sediment.

<u>Restorative Road Treatments.</u>

Decommissioning 37.4 road miles, hydrologically storing 34.8 road miles, and upsizing 15 undersized stream pipes would decrease erosion and sedimentation from the road system in the long-term. Road density would decrease from 1.3 mi/mi^2 to 1.1 mi/mi^2(18%)in Buttermilk and 2.1 mi/mi^2 to 1.5 mi/mi^{2}in Libby (28%) 40 stream crossings total would be removed across the project area including 6 perennial streams, 23 intermittent streams, and 11 ephemeral draws.

Road decommissioning, road closures, and culvert replacement (AOPs and stream pipes), will increase surface erosion immediately following treatment and decrease erosion 1-2 years following treatment (Luce and Black, 2001). The disturbance may increase stream turbidity but isexpected to be temporary and with minor impacts.Madej (2001) found most stream crossings(80%) produce very little sediment several years after removal. Other studies report most sediment production occurs on a small percentage of decommissioned stream crossings,usually during the first storms after excavation (Klein 2003, Pacific Watershed Associates 2005). The project proposes armoring perennial stream crossings and reducing the number of road-stream crossings. This would put the project area on an immediate sediment reduction trend.

Decommissioned roads would allow for greater infiltration and reduce sheet, rill, and gully erosion. Peak flows near decommissioned roads may decrease as infiltration capacity on adjacent land is increased. Stability would increase on crossings where aquatic organism passage is improved and on roads where culverts are removed or upgraded. Replacing undersized culverts with structures designed to accommodate the 100-year flood would increase stability and reduce plugging and failure potential. Hydrologic road storage is another affective method for maintaining low use roads for long-term land management when stream crossings are removed and water bars are installed. This treatment could include removing stream crossings, building waterbars, and surface scarification. Removing stream crossings eliminates the primary point where roads deliver sediment to streams, thereby reducing road-stream interactions and sediment delivery.

In summary, the restorative road treatments would result in a long-term, beneficial effect to hydrologic and aquatic resources. The benefits would range from negligible to moderate with the most beneficial benefit occurring within the Libby sub-watershed. Chronic sediment delivery would decrease, resulting in a minor to moderate beneficial effect to at-risk fish habitat.

Summary of Effects to ESA Fish Species

There is potential for direct effects to ESA fish species when falling trees into streams, AOP construction, and installing posts at beaver release sites. The project could result in some physical harm or acute mortality to a few individuals. Fish may be crushed from tree felling, heavy equipment, and posts installation. De-fishing the AOP sites would shock fish with electric current that could cause harm or mortality. The disturbances would displace fish to areas where vulnerable to predators.Adult fish are few in number and they would likely move out of the area and be unharmed. Juveniles are the mostly likely life stage to be impacted because they are more abundant and do not swim as fast. To minimize direct effects, work in occupied fish habitat would occur during the designated instream work window. This period is outside of fish spawning stages when fish are most vulnerable. AOP work areas would be isolated and fish would be removed. These actions would minimize the potential for direct effects. The project fish biologist estimates up to 100 juveniles would be disturbed across the entire project area and less than five would be harmed or killed.

Temporary disturbances to critical habitat would occur from the instream work and may occur from road treatments and other actions upstream. Impacts to critical habitat would be temporary increases in fine sediment levels. Design criteria and mitigation measures are expected to reduce the level of habitat impacts to minor levels. In the long-term, habitat quality in Buttermilk and Libby Creek would improve, moving habitatcritical habitat towards desired conditions.

Summary of Effects to Region 6 Sensitive Species and Management Indicator Species

Similar to the ESA fish species, direct impacts to individual fish and small-scale, localized habitat impacts could result in some harm to individual trout. See discussion above under ESA fish species. Alternative 2 *may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or cause a loss of viability to the population or species of IRRT and WSCT*.

Summary of Effects to Essential Fish Habitat (EFH)

The extent of original coho salmon habitat in the Methow Sub-basin is not known and current reintroduction efforts have not result in many known spawning adults or juveniles in any project area streams, with the exception of the lowest reach of Libby Creek within several hundred feet of the Methow River. All Chinook salmon habitat is over a quarter mile below the project treatments. Impacts to combined steelhead and spring Chinook critical habitat, as a rough coho surrogate, are considered unsubstantial, based on the Biological Assessment. No negative impacts to EFH are expected.

Sensitive Species List Species Determination SummaryCumulative Effects

Spatial and Temporal Context for Effects Analysis

The spatial boundary for analyzing the cumulative effects to hydrologic and aquatic resources are the Buttermilk and Libby Creek sub-watershed boundaries (HUC12). Project effects are not expected to extend outside of these sub-watersheds. The temporal scale for cumulative effects on stream channel function is 30 years. The temporal scale for cumulative effects on water quality, riparian function, and watershed condition is 10 years. These are the times for watershed projects to improve stream channel function.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

Understanding watershed history (i.e., past management activities, hydrologic events, wildfire) is important to build a temporal context of past impacts, current condition and potential future effects. Analysis of watershed history is essential to help predict effects of future management activities on water quality and watershed condition. Ongoing on reasonably foreseeable actions in the Mission Project area sub-watersheds include livestock grazing, road maintenance, snowmobile trail grooming, fire suppression, recreation, and invasive weed treatments. Additional projects and conditions that contribute to potential cumulative effects are outlined in the “Cumulative Effects Considerations” document in the project file.

The Mission Restoration project is not expected to negatively impact cumulative watershed effects to water quality, riparian function, channel morphology, and watershed conditions because treatments in Alternative 2 would improve conditions across the watershed (Figure 29). Localized increases of erosion and sedimentation would occur from the instream work and some riparian treatments, however this increase would be short in duration and is not expected to have a cumulative effect at the watershed scale.

Figure 28: Resource Indicators and Measures for Cumulative Effects

Resource Element	Indicator	Measure	Alt 2	Past, Present, Future Actions	Cumulative Impacts
Water Quality (Sediment)	• Road density	• Number of Catchment Rankings Lowered	5 (3 High to Moderate, 2 Moderate to Low)	0	5 (3 High to Moderate, 2 Moderate to Low)
	• Road drainage network increase		5 (2 High to Moderate, 3 Moderate to Low)	0	5 (2 High to Moderate, 3 Moderate to Low)
	• Riparian road density		8 (4 High to Moderate, 4 Moderate to Low)*	0	8 (4 High to Moderate, 4 Moderate to Low)*
	• Road-stream crossing density		6 (1 High to Low, 1 High to Moderate, 4 Moderate to Low)	0	6 (1 High to Low, 1 High to Moderate, 4 Moderate to Low)
	• Groundcover	• Acres of bare soil	+105 acres	Negligible	+105 acres
Water Quantity (base flow)	• Beaver habitat	• Number of beaver release sites	8 sites 8.3 miles 5.6 miles	Negligible	8 sites 8.3 miles 5.6 miles

Aquatic Habitat	• Stream channel complexity	• Miles of stream restored with course woody debris	8 AOPs	Negligible	8 AOPs
	• Fish distribution	• Miles of stream accessible to fish	8 sites	0	8 sites
		• Number of aquatic organism passage pipes installed	8.3 miles	0	8.3 miles

Resource Indicator: Road Density

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Increase in road drainage network

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Riparian Road Density

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Stream Crossings per Mile

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Ground Cover

The overlap with grazing impacts, the road network and recreation will have slight cumulative impact upon sediment but the effects will not be measurable.

In the long-term, rocking stream crossings, decommissioning and hydrologically closing roads, upsizing stream pipes, constructing hardened fords would reduce chronic sediment delivery and reduce the potential for episodic road failures. The long-term cumulative effect would be a beneficial, minor positive impact.

Resource Indicator: Beaver Habitat

There are no projects in the area that would have cumulative impacts. Some naturally occurring beaver colonies exist in the project area. Existing beaver populations may increase and expand their distribution, increasing wetland habitat.

Resource Indicator: Stream Channel Complexity

There are no projects in the area that would have cumulative impacts. Some natural wood recruitment would occur over time from natural tree mortality and blowdown, increasing channel complexity.

Resource Indicator: Fish Distribution

There are no projects in the area that would have cumulative impacts.

Conclusion

Alternative 2 would have a May Affect, Likely to Adversely Affect to steelhead and bull trout species and their critical habitat. Adverse impacts would be temporary and at negligible to minor in consequence. Habitat conditions for ESA listed species would move towards desired habitat conditions. This project would contribute towards the recovery of these species across the Upper Columbia Basin.

Alternative 3 – Proposed Action

As stated under Alternative 3, most proposed treatments are identical. This alternative's objective is to assess the effects of a transportation plan that prioritizes ecological restoration through reducing road impacts to hydrologic, aquatic and wildlife resources. The following environmental consequences section will discuss effects additional road decommissioning, closures, rock armoring, and conversion of some small stream crossings to hardened fords. Figure 30 displays the changes to hydrologic and aquatic resource indicators.

Project Design Features and Mitigation Measures

The Hydrologic/Aquatic Design Features and Mitigation Measures are identical to those discussed under Alternative 2.

Effects

Figure 29: Resource Indicators and Measures for Alternative 3

Resource Element	Resource Indicator	Measure	Alt 3 (% Change)
Water Quality (Sediment)	Catchment Road Density	Number of Catchment Rankings Lowered	8 (5 High to Moderate, 3 Moderate to Low)
	Road Drainage Network Increase	Number of Catchment Rankings Lowered	10 (2 High to Low, 2 High to Moderate, 6 Moderate to Low)
	Riparian Road Density	Number of Catchment Rankings Lowered	11 (2 High to Low, 5 High to Moderate, 4 Moderate to Low)*
	Road-stream Crossing Density	Number of Catchment Rankings Lowered	9 (1 High to Low, 7 High to Moderate, 1 Moderate to Low)
	Ground Cover	Amount of bare soil	+105 acres
Water Quantity (Base Flow)	Beaver Habitat	Number of beaver release sites	8 sites
Aquatic Habitat	Stream Channel Complexity	Miles of stream	8.3 miles
	Fish Distribution	Miles of accessible habitat	5.6 miles
		Number of aquatic passage pipes installed	8 AOPs

* Changes in catchment rankings listed are for the averaged catchment road density and riparian road density, showing where riparian road density coordinated with catchment density, which is a more meaningful metric.

Resource Indicator: Road Density

In this alternative, ~57 miles of road decommissioning would occur. Focus would be on removing riparian roads. At the sub-watershed scale, road density would decrease from 1.3 mi/mi^2 to 0.82 mi/mi^2 in Buttermilk (~37%),2.1 mi/mi^2 to 1.05 mi/mi^2in Libby (~50%).. ~29 miles of roads would be hydrologically closed across the project area. Putting roads in hydrologic storage may include removing stream crossings, constructing water bars, and surface scarification.

Under Alternative 3, road density would decrease in most catchments with roads across the project area. Fivehigh road density catchments would drop to moderate, making a substantial reduction in road density in high concentration areas. Threemoderate catchments would drop to a low ranking. Figure 31displays catchment road density under Alternative 3. In Buttermilk, two catchments with a high ranking would drop to moderate and one would go from moderate to low. In Libby Creek three catchments would move from high to moderate densities and twomoderate would move to low road density. Prioritizing the removal of riparian roads would focus on high aquatic risk roads and result in greater reduction of road-stream interactions. Removing riparian roads at this level would result in moderate long-termbeneficial effect to road density and chronic sediment delivery sources across the project area.

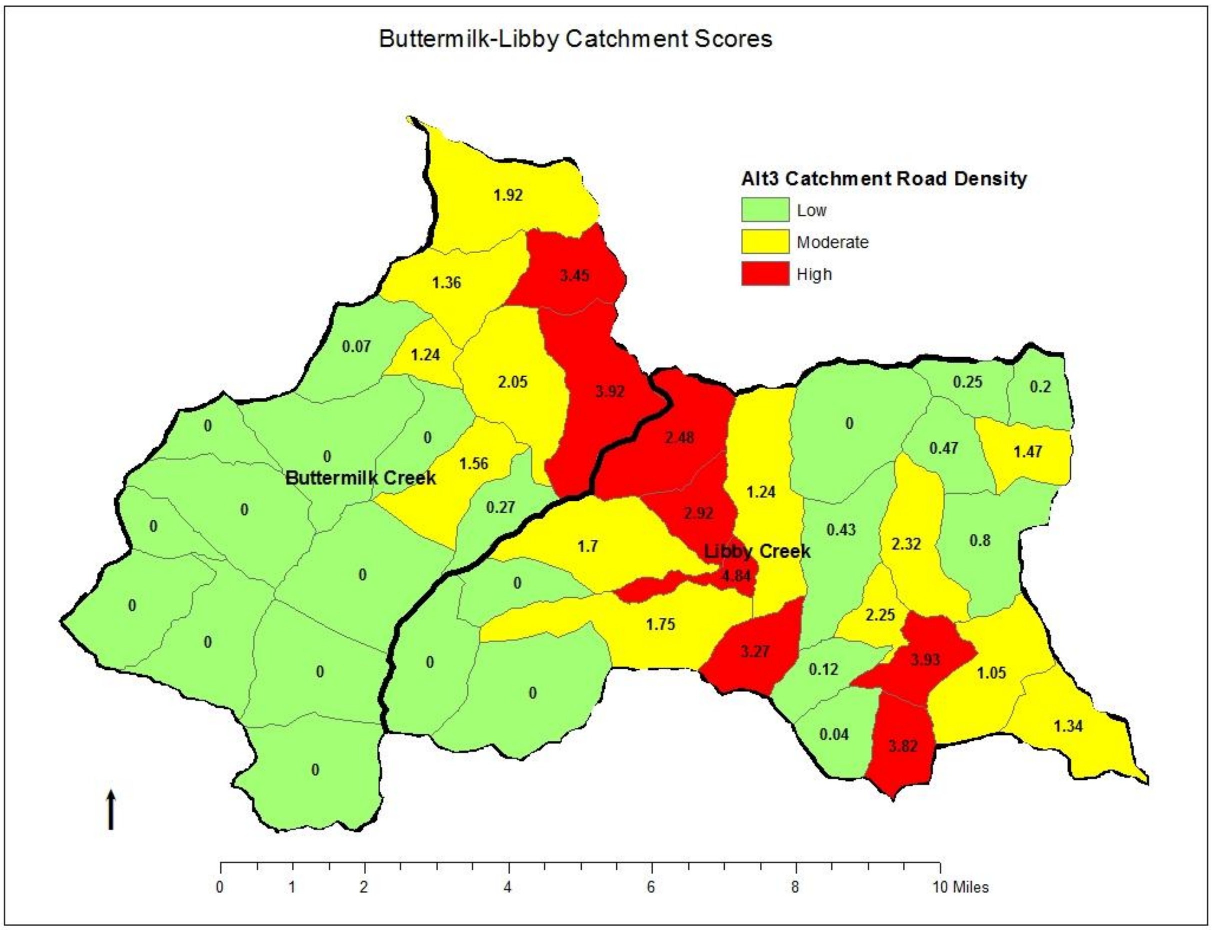

Figure 30: Alternative 3 road density across the Mission Project catchments.

Resource Indicator: Increase in road drainage network

Alternative 3 would reduce theroad drainage network in most catchments across the project area. The road drainage network would decrease by ~41% across the project area. At the sub-watershed scale, Buttermilk decreased by ~30% and Libby by ~48%. Figure 32 displays catchment road drainage network under Alternative 2. Decommissioning all the roads on the west side of WF Buttermilk changes one catchment from a high to lowrating. In Libby, nine catchments would improveto lower drainage network rankings with the proposed road changes.The additional reduction in road drainage network would result in a minor beneficial long-term effect in the Buttermilk sub-watershed and a moderate beneficial long-term effect in the Libby sub-watershed.

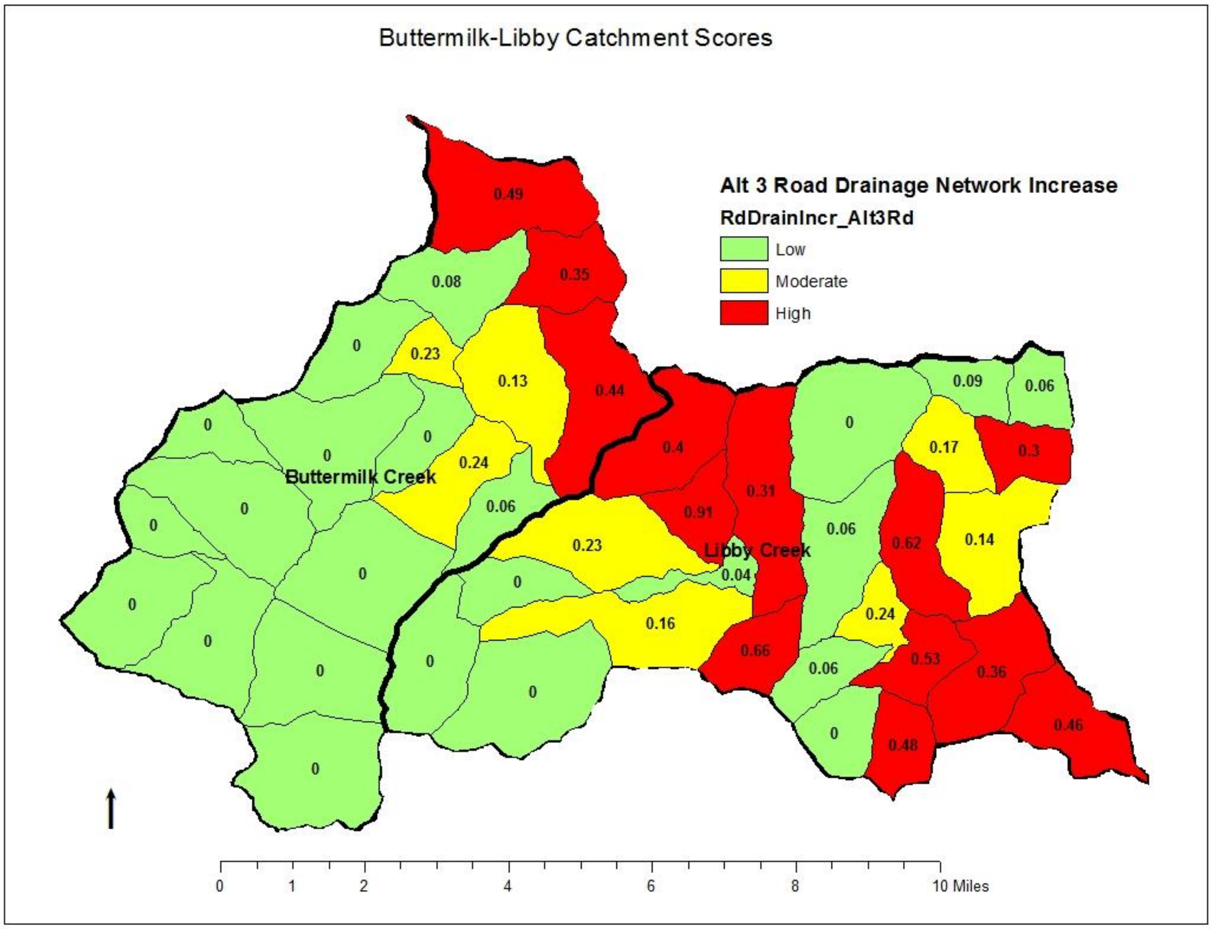

Figure 31: Alternative 3 increase in drainage network from the road system across Mission Project catchments.

Resource Indicator: Riparian Road Density

Riparian road density would decrease by about 42% across the project area. In the Buttermilk sub-watershed, road density would decrease by ~32% and in Libby ~50% (Figure 33).At the catchment scale in Buttermilk, one catchment would change from a highcombined density ranking to a low. Libby would have nine catchments drop in combined density rankings. The averaged catchment/riparian road density rankingswould decrease in key areas around NF and SF Libby, Ben Canyon, and Hornet Draw Creeks (Figure 33).

The reduction in riparian roads willlead to the greatest reduction in chronic sediment sources across the Libby sub-watershed. Streams within the Libby sub-watershed would realize a moderate long-term improvement to fine sediment levels. Buttermilk is expected to have a considerable improvement in the one catchment, but a minor long-term improvement across the sub-watershed.

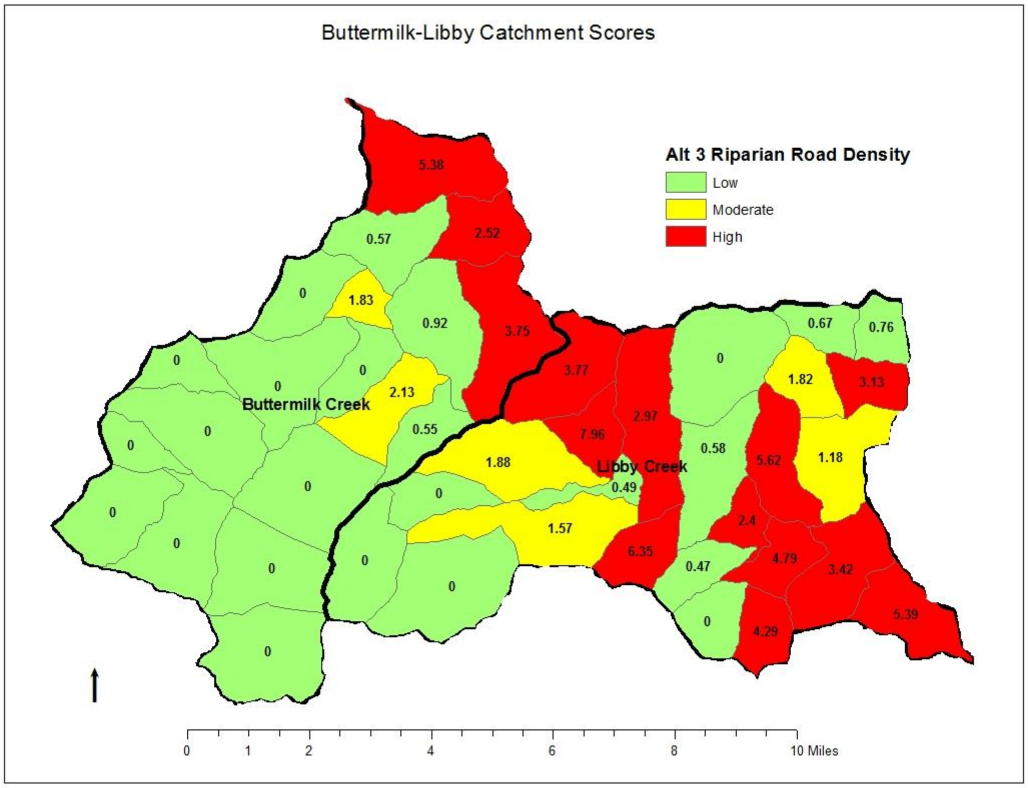

Figure 32: Alternative 3 riparian road density across Mission Project catchments.

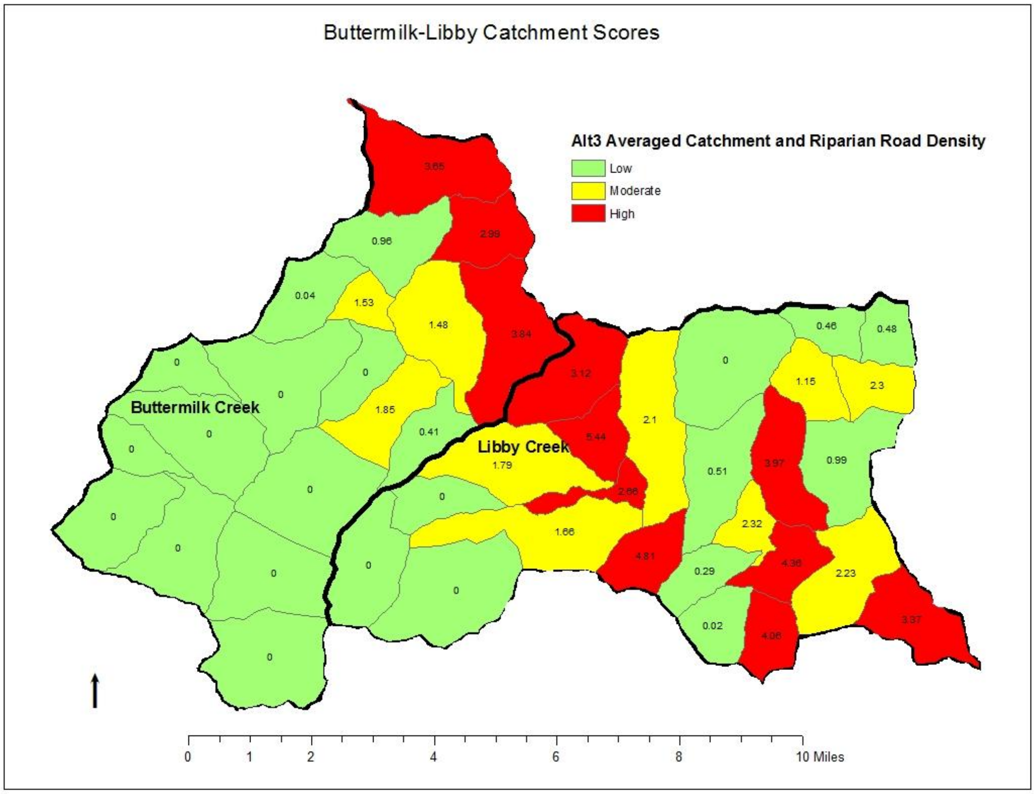

Figure 33: Alternative 3 averaged catchment and riparian road density across Mission Project catchments.

Resource Indicator: Stream Crossings per Mile

Alternative 3 would remove ~52 stream/draw crossings across the project area that includes 8 perennial streams, 30 intermittent streams, and 14 ephemeral draws. Stream crossings per mile density would decrease by about 44% across the project area. Within the Buttermilk sub-watershed it would drop by 34%and in Libby~52% (Figure 34).

Reductions in catchment ratings would occur in both sub-watersheds. Two catchments in Buttermilk would go from moderate to low ranking. Libby sub-watershed would have seven catchments move to lower ranking levels. One catchment would go from high to low, one from high to moderate, and five from moderate to low. Buttermilk would see a minor reduction in sediment sources leading to a beneficial long-term minor effect while Libby would see a moderate reduction in sediment sources (long-term, beneficial, and moderate effects).

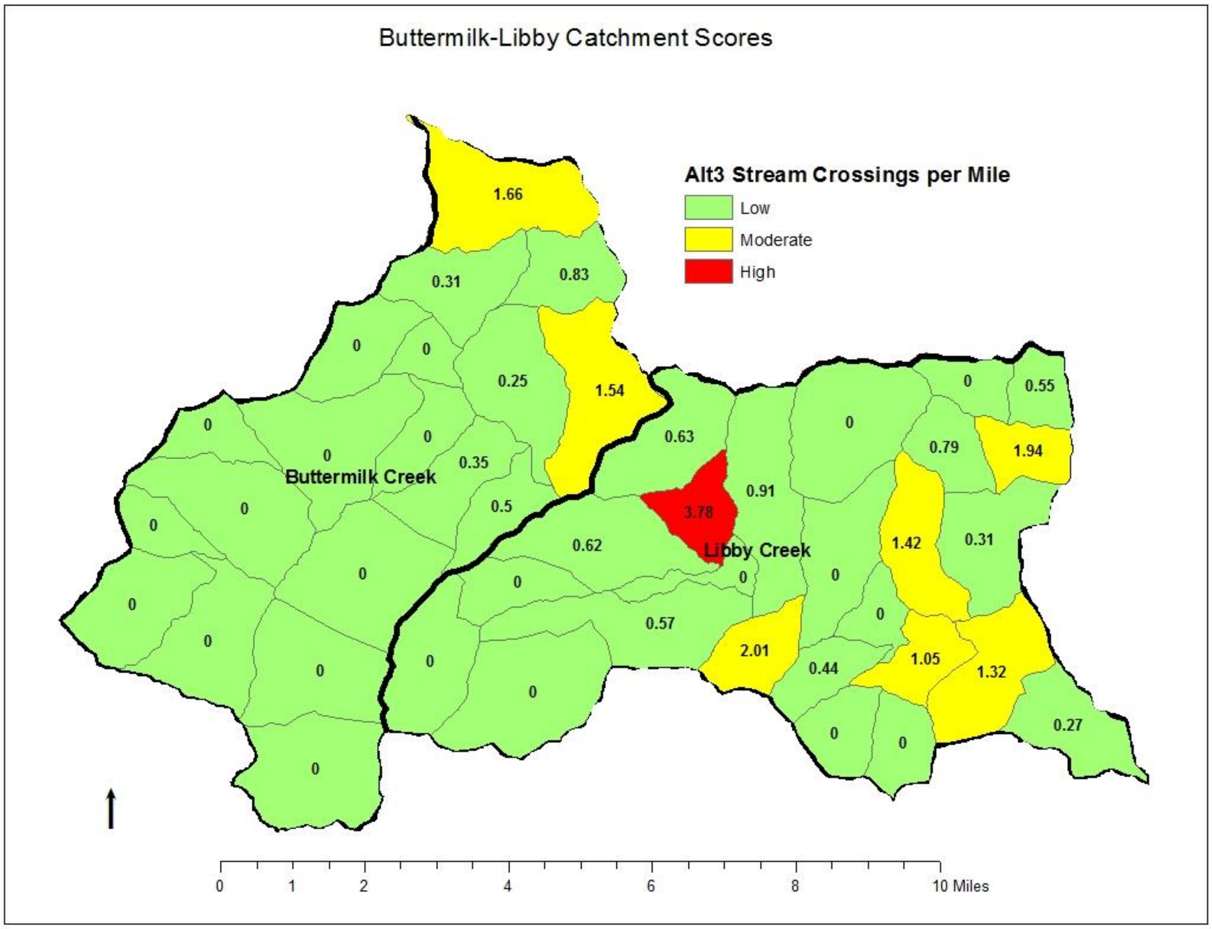

Figure 34: Existing number of stream crossings per mile of stream across Mission Project area catchments.

<u>Restorative Road Treatments</u>

All harvest related road treatments are the same as under Alternative 2. This section focusses on the more restorative road alternative.

Decommissioning 57.2miles of road, hydrologically storing 34miles, rocking/ armoring 33 stream crossings, upsizing 15 undersized stream pipes, and converting 4 stream crossings to fords would result in a considerable decrease in chronic stream sedimentation from the road system. At the sub-watershed scale, road density would decrease from 1.3 mi/mi^2 to 0.82 mi/mi^2 in Buttermilk (~37%) and 2.1 mi/mi^2 to 1.05 mi/mi^2 in Libby (~50%)34 miles of roads would be hydrologically closed across the project area. ~52 stream crossings total would be removed across the project area.

Removing 57 miles of roads and up to 52 stream crossings would result in a substantial reduction in sediment yield across the project area. This alternative would move the Libby and Buttermilk sub-watersheds the most towards a desired condition for stream sediment levels over the long-term and the anticipated beneficial effect would be moderate overall.

This alternative would result in the greatest benefit for reducing road influence on the watershed hydrology and fine sediment levels in at-risk fish habitat. Fine sediment levels would measurably reduce within a few years of completing road restoration.

Summary of Effects to ESA Fish Species

Direct effects would be the same as Alternative Two. Additional road decommissioning would result in a moderate improvement to fine sediment levels in habitat in the Libby Creek drainage. The ESA effects determination would the same as described under Alternative 2

Summary of Effects to Region 6 Sensitive Species and Management Indicator Species

Effects would the same as under Alternative 2, with a greater reduction in fine sediment levels. Alternative 3*may impact individuals or habitat, but will not likely contribute to a trend towards federal listing or cause a loss of viability to the population or species of IRRT and WSCT*.

Summary of Effects to Essential Fish Habitat (EFH)

Effects would be the same as Alternative 2.

Cumulative Effects

Spatial and Temporal Context for Effects Analysis

The spatial boundary for analyzing the cumulative effects to hydrologic and aquatic resources are the Buttermilk and Libby Creek sub-watershed boundaries (HUC12). The effects are similar to described under Alternative 2.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

The additional road decommissioning and other road treatments is expected to achieve greater aquatic habitat improvement of reduced sediment levels. Other effects would be the same as Alternative 2 (Figure 35).

Figure 35: Resource Indicators and Measures for Cumulative Effects

Resource Element	Indicator	Measure	Alt 3	Past, Present, Future Actions	Cumulative Impacts
Water Quality (Sediment)	• Road density	• Number of Catchment Rankings Lowered	8 (5 High to Moderate, 3 Moderate to Low)	0	8 (5 High to Moderate, 3 Moderate to Low)
	• Road drainage network increase		10 (2 High to Low, 2 High to Moderate, 6 Moderate to Low)	0	10 (2 High to Low, 2 High to Moderate, 6 Moderate to Low)
	• Riparian road density		11 (2 High to Low, 5 High to Moderate, 4 Moderate to Low)*	0	11 (2 High to Low, 5 High to Moderate, 4 Moderate to Low)*
	• Road-stream crossing density		9 (1 High to Low, 7 High to Moderate, 1 Moderate to Low)	0	9 (1 High to Low, 7 High to Moderate, 1 Moderate to Low)
	• Groundcover	• Acres of bare soil	+105 acres	Negligible	+105 acres

Water Quantity (base flow)	• Beaver habitat	• Number of beaver release sites	8 sites 8.3 miles 5.6 miles	Negligible	8 sites 8.3 miles 5.6 miles
Aquatic Habitat	• Stream channel complexity	• Miles of stream restored with course woody debris	8 AOPs	Negligible	8 AOPs
	• Fish distribution	• Miles of stream accessible to fish	8 sites	0	8 sites
		• Number of aquatic organism passage pipes installed	8.3 miles	0	8.3 miles

Resource Indicator: Road Density

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Increase in road drainage network

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Riparian Road Density

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Stream Crossings per Mile

There are no projects in the area that would have cumulative impacts.

Resource Indicator: Ground Cover

Effects to this indicator are the same as described under Alternative 2.

Resource Indicator: Beaver Habitat

There are no projects in the area that would have cumulative impacts. Some naturally occurring beaver colonies exist in the project area. Existing beaver populations may increase and expand their distribution, increasing wetland habitat.

Resource Indicator: Stream Channel Complexity

There are no projects in the area that would have cumulative impacts. Some natural wood recruitment would occur over time from natural tree mortality and blowdown, increasing channel complexity.

Resource Indicator: Fish Distribution

There are no projects in the area that would have cumulative impacts.

Conclusion

Alternative 3 would have the same effects for vegetation and fuels treatments, harvest related road use, AOPs, stream culvert upsizing, coarse wood placement, and beaver release treatments. See Alternative 2 for details.

The additional road decommissioning, road closure, rock armoring, and hardened ford construction under Alternative 3 would create direct short-term and negligible to minor adverse impacts to water quality and fish habitat. No additional direct effects to individual fish species would occur under this alternative. In the long-term, the restorative treatments would create long-term minor to moderate beneficial improvements to water quality and at-risk fish habitat. In conclusion, when combined with past, present, and reasonable foreseeable future actions, Alternative 3 would be expected to have direct short-term and negligible to minor adverse impacts to water quality and fish habitat and long-term, minor to moderate beneficial effects to hydrologic and aquatic resources.

Other Relevant Mandatory Disclosures

ESA Fish Species and Critical Habitat Effect Determination

Steelhead and bull trout are present in theButtermilk and Libby Creek drainages.Direct effects to individual fish are expected to occur during instream restoration work. Effects could include some physical harm or acute mortality to a few individuals. Steelhead and bull trout would be displaced within the project area where they may be more vulnerable to predators. Direct effects are expected to displace up to 100 juveniles across the entire project area and harm or kill less than five individuals. This level of take would be insignificant to the local population and less than five would be harmed or killed. The project fish biologist believes that adverse disturbance effects, minor physical harm or mortality, and adverse effects to stream sediment levels will cause primarily sub-lethal injury of steelhead and bull trout in all free-swimming age classes. The scope and severity of these effects will be too limited to result in changes in the reproduction, numbers, or distribution of the local populations affected.

The potential for disturbance, physical harm or mortality and temporary sediment increases in critical habitat exists.The project may result in ‘take’ of steelhead and bull trout species. The project is considered “likely to adversely affect” steelhead and bull trout for the short term. Chinook are miles below any instream work and the magnitude of effects would result in small, insignificant effects and there is considered “not likely to adversely affect” them. The project “may affect, likely to adversely affect” designated critical habitat for steelhead and bull trout only.

Consultation with the U.S. Fish and Wildlife Service and NOAA Fisheries was completed on XXX. A biological opinion was issued on XX that included terms and conditions the Mission Project would follow.

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

This project conforms to the Okanogan Forest Plan (the Forest Plan), as amended by Decision Notice and Environmental Assessment for the Interim Strategies for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH, USDA and USDI 1995). The project site is located on the boundary of the Northwest Forest Plan management area. The project is consistent with standards and guidelines of these land management plans.

Activity Type – Water Quality (page 4-31 and 32)

> *S&G 2-14 - in streamside management units class IV streams, management activities shall not degrade water quality for aquatic resources below current Washington State water quality standards (Chapter 173-210 WAC), except for temporary changes because of permitted activities*

Existing fine sediment levels in the Libby sub-watershed project area streams appears to be functioning at risk. Mitigation measures such as rock armoring perennial stream crossings, maintaining no harvest stream buffers, following low intensity underburning intensities in RRs, and isolating the work sites for instream workwill minimize short-term sediment impacts. Fine sediment levels are expected to improve once the riparian road work is complete.

Activity Type – Fisheries (page 4-31 and 32)

> *S&G 3-1 - Maintain or enhance biological, chemical, and physical qualities of forest fish habitats.*

The project meets this guidance by protecting instream habitat with no-treatment buffers. The restorative road treatments would reduce chronic fine sediment delivery to streams. Aquatic habitat restoration treatments would improve degraded or at-risk habitat indicators.

Activity Type – Fisheries (page 4-31 and 32)

> *S&G 3-2 - Rehabilitate fish habitats where past management activities have adversely affected their ability to support fish populations. Those fish habitats identified as having impacts from management activities shall be managed to show an upward trend with at least a 5 percent increase in condition per year until objectives for the habitat are met.*

The project meets this guidance via active and passive means of restoration.

Activity Type – Fisheries (page 4-31 and 32)

> *S&G 3-3 - Sediment in fishery streams shall be maintained at levels low enough to support good reproductive success of fish populations as well as adequate instream food production by indigenous aquatic communities to support those populations*
>
> > *Fines - Fines (<1.O mm) in spawning areas (pool tail-outs and glides) should be maintained at less than 20 percent as the area weighted average.*

Existing fine sediment levels in the Libby project area steams appear to be functioning at risk.Decommissioning riparian roads would reduce the fine sediment delivery to streams. Fine sediment levels in Libby Creek are expected to have a net reduction in the long-term.

Activity Type – Fisheries (page 4-31 and 32)

S&G 3-5 - Provide an average of at least 20 pieces of large wood per 1,000 lineal feet of stream channel on fish bearing streams to provide for aquatic needs.

Class I & ll Streams - Minimum length 35 feet and average diameter of 12 inches with at least 20 percent over 20 inches.

The project avoids removal of overstory trees within at least 100-feet of any stream. Adding wood to streams would increase wood loading in depleted areas.

Activity Type – Fisheries (page 4-31 and 32)

S&G 3-6 - Manage riparian vegetation to provide sufficient trees near the stream channel to act as a source of large woody debris for future instream fish habitat needs.

See response to 3-5.

Activity Type – Fisheries (page 4-31 and 32)

S&G 3-7 - Channel disturbing activities should be conducted at minimum flow, or outside of critical spawning and incubation periods.

All instream treatments would occur during the designated instream work window, which falls during the low flow period and outside of spawning and redd timing.

Activity Type – Fisheries (page 4-31 and 32)

S&G 3-8 - Structures, such as bridges, culverts, and dams, placed in fish bearing streams shall be designed to allow upstream and downstream passage of both adult and juvenile fish. During construction utilize special installations (i.e. sediment traps, settling ponds, coffer dams, riprap, etc.) to keep sediment from reaching the stream.

All new permanent culverts proposed would be capable of passing the 100-year flow event and consistent to the Forest Service-WDFW MOU for hydraulic projects.

Activity Type – Soil and Water (page 4-45 and 46)

S&G 13-2 - All activities shall comply with State requirements for protection of waters in the State of Washington (Washington Administrate Code, Chapters 173-201 and 202) through planning, application, and monitoring of Best Management Practices (BMPs) in conformance with the Clean Water Act, regulations, and Federal guidance.

BMPs and design features would prevent for chemical spills in surface water and minimize stream turbidity levels. See above for sediment reducing measures.

Activity Type – Soil and Water (page 4-45 and 46)

> *S&G 13-3 - In cooperation with Washington State, the Forest shall use the following process;*
>
> > *Select and design BMPs based on site-specific conditions, technical, economic, and institutional feasibility, and the water quality standards for those waters potentially impacted.*
> >
> > *Implement and enforce BMPs.*
> >
> > *Monitor to ensure that practices are correctly applied as designed.*
> >
> > *Monitor to determine the effeteness of practices in meeting design expectations and in attaining water quality standards.*
> >
> > *Evaluate monitoring results and mitigate where necessary to minimize impacts from activities where BMPs do not perform as expected.*
> >
> > *Adjust BMP design standards and application when It is found that beneficial uses are not being protected and water quality standards are not being achieved to the desired level. Evaluate the appropriateness of water quality criteria for reasonably assuring protection of beneficial uses. Consider recommending adjustment of water quality standards.*

Forest Service National Best Management Practices for Water Quality Management on National Forest System Lands (USDA 2012) are required protective measures to be applied during the development and implementation of all projects.

Northwest Forest Plan

Project type and site-specific S&Gs listed below apply to all RRs as well as any activity potentially degrading RR. The Mission Project's consistency with each S&G is discussed below:

Timber Management

> *TM-1 Prohibit timber harvest, including fuelwood cutting, in Riparian Reserves, except as described below.*
>
> > *Apply silvicultural practices for Riparian Reserves to control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain Aquatic Conservation Strategy objectives.*

The Mission is consistent with TM-1 due to avoiding most RRs. Where harvest occurs in RRs, the objective is to restore riparian vegetation conditions.

Road Management

> *RF-2. For each existing or planned road, meet Aquatic Conservation Strategy objectives by:*

a. Minimizing road and landing locations in RRs.
b. Preparing road design criteria, elements, and standards that govern construction and reconstruction.
c. Minimizing disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flow.
d. *Avoiding wetlands entirely when constructing new roads.*

Design features described in AppendixXX details the process for minimizing landing construction within RRs. No new road construction would occur within RRs.

All road work would be designed and implemented with qualified road engineers.

High aquatic risk roads were identified from field work and GIS analysis. Where possible, roads that disrupt hydrologic flow paths and have potential to diver streams were proposed for decommissioning.

No new road construction would occur.

RF-4. New culverts, bridges and other stream crossings shall be constructed, and existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associated bedload and debris.

All new permanent culverts proposed would be capable of passing the 100-year flow event and consistent to the Forest Service-WDFW MOU for hydraulic projects, which includes provisions for protecting water quality and aquatic life.

RF-6. Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams.

All known fish barrier culverts are proposed for upgrading to fish friendly passage structures.

Fire/Fuels Management

FM-1. Design fuel treatment strategies, practices, and activities to meet Aquatic Conservation Strategy objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuels management activities could be damaging to long-term ecosystem function.

Reintroduction of low intensity backing fire along and into RHCAs sensitive watersheds, and applied low intensity fire along and inside RHCAs in low sensitivity watersheds will help to increase stand resiliency, restore historic vegetation patchiness, species composition, and promote large and old trees. Deciduous vegetation, shrubs, and down material on the ground in RHCAs will not be targeted and is expected to only be marginally reduced.

FM-4. Design prescribed burn projects and prescriptions to contribute to attainment of Aquatic Conservation Strategy objectives.

See discussion above.

Project Consistency with the Aquatic Conservation Strategy Objectives

The Northwest Forest Plan identifies nine Aquatic Conservation Strategy Objectives (USDA and USDI 1994) on page B-11 that are reviewed for each proposed project. The following discussion states the objective, describes relevant existing conditions and effects and determines if the project would maintain the existing conditions or lead to improved conditions in the long-term.

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape features to ensure protection of aquatic systems to which species, populations, and communities are uniquely adapted.

Past timber harvest, road construction, fire suppression, and grazing have altered aquatic systems and landscape scale processes in the Buttermilk and Libby Creek sub-watersheds. Past timber harvest and fire suppression within the dry forest vegetation types converted forest conditions from a structure and composition typical of high frequency, low intensity fire to over-stocked forest conditions with high intensity stand replacement fires.

Forest fire regime, road densities, climate, and the distribution of soil types and plant communities are some of the landscape-scale features affecting aquatic systems in project area. The objective for the thinning and hazard fuel reduction is to compensate for an altered fire regime and restore certain plant communities. The project objective is to restore the function of landscape-scale processes, such as wildfire, in order to protect the complexity and distribution of plant communities (including riparian areas) across the landscape. The Mission Projectis expected to maintain and slightly improve the distribution, diversity and complexity of watershed and landscape features.

2. Maintain and restore spatial and temporal connectivity within and between watersheds.

Several barrier culverts were replaced in the last 10 years improving aquatic connectivity within the Buttermilk and Libby Creek sub-watersheds. Several barrier pipes remain and this project proposes to fixthese crossings to allow for full aquatic and riparian species passage. The proposed actions would not create any barriers for fish within the project area. The proposed project wouldimprove and move towards attainment of ACS Objective 2.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

Removing culverts through road decommissioning and road closure will eliminatesome artificial constraints on the shape of small streams in the project area. This will help restore the physical integrity of these streams. Some activities would result in a minor temporary increase in fine sediment levels within project area streams. Improvements to coarse wood levels would increase channel stability and create more desirable channel conditions. Projects are expected to maintain the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems.

Water temperature and sediment (turbidity) levels are the main water quality indicator functioning at risk across the project area. The proposed commercial harvestwould maintain shade levels and not affect stream temperature.

Most underburning in Riparian Reserves associated with perennial streams has roads as control lines. In these areas, the roads are at least 100 feet from adjacent streams and active lighting would stop within 100 feet of perennial streams and 25 feet of intermittent streams. Within Riparian Reserves, active lighting has a resource objective of maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 50% ground cover/organic material on surface. Fire would be allowed to back towardsstreams when resource objectives can be met. Consequently, vegetation mortality levels are expected to be low. It is very unlikely that measurable change in stream shade levels would occur, especially where fish occur. However, some localized shade reduction could occur, but it is expected to be insignificant to stream temperatures, especially where listed fish occur, miles downstream. Therefore, proposed fuels treatments would result in an insignificant negative effect to temperature. The proposed projects are expected to maintain water quality necessary to support healthy riparian, aquatic, and wetland ecosystems at the project and watershed scale.

See the discussion below for effects to turbidity.

5. Maintain and restore the sediment regime under which aquatic ecosystems were formed.

Thinning within the outer portion of Riparian Reserve has a low probability of introducing sediment to streams. About 60 percent of the harvest within RRs would occur over frozen ground with little ground disturbance and no sediment delivery to streams. The other 40 percent would be optional summer or winter harvest. Protection buffers of at least 100 feet from streams would be applied. Sweeney et al. (2014), who did consider suspended sediment, suggests 30 meter (98ft) buffers are necessary to trap ultra-fine sediment from reaching streams. Based on these measures and recent research, we expect little to no sediment delivery to occur on the units potentially harvested during the summer months. Activities outside of Riparian Reserves, such as tree harvest using mechanical equipment and fuels reduction, are unlikely to contribute sediment to the streams because the full reserve widths would prevent sediment from reaching streams. Design details that minimize erosion and sediment movement throughout the units are listed in Appendix A.

The proposed road maintenance, construction (temporary roads), decommissioning, closure, and log hauling would increase sediment yield. Due to hydrologic connectivity with roads, sediment could reach fish habitat. This increase would last an estimated 1-3 years following treatment. Design Featuresand Mitigation Measures, listed in Appendix Awould minimize sediment delivery to streams. Measures like rock armoring perennial stream crossings prior to log hauling and working under dry weather conditions would minimize fine sediment mobilization. The amount of sediment reaching streams, using design features and BMPs would be minor.

Once the road construction, maintenance, and decommissioning sites stabilizes and log hauling ceases, the net sediment yield for the Buttermilk and Libby Creek drainages would reduce. The reduction in sediment delivery to streams, coupled with other efforts across the watershed, would act cumulatively to provide long lasting improvements to watershed health in the project area. At the watershed scale, the short-term increase in sediment delivery and long-term reductionwould improve the sediment regime.

6. Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient and wood routing.

The current road network increases the stream drainage network by ~ 30%. Additionally, historic beaver colony were abundant and the wetland habitat they created provided important natural water storage that sustained higher summer and fall base flows. Currently, base flows are reduced due to irrigation withdrawals off National Forest lands.

The proposed harvest, fuels treatment, and road management activities would change the drainage network. Collectively, with the miles of skid trails and firelines, there would be a temporary increase in the drainage network. Most new temporary drainages would be disconnected to the stream network. In the long-term, once the skid trails and fire lines recover, the miles of road decommissioning would result in a net decrease in the miles of artificial streams associated with roads from 30 to 44 percent, depending on the amount of road decommissioning selected.

An objective of this project is to improve base stream flow within the Buttermilk and Libby Creek sub-watersheds. Establishing eight beaver sites work to improve base flows and move towards a more natural flow regime. The beaver colony sites would function as ‘sponges’ soaking up early spring runoff and delivering that water from underground storage where releases it slowly, resulting in increased summer and fall flows. Previous beaver release sites in the Methow Valley Ranger District were monitored and documented to show increased water storage and improved summer flows downstream (Pollock et al. 2003).

The negative effects associated with harvest and fuels activities and the associated road work, when considered collectively with the beaver release sites, would remain an insignificant negative affect for a few years, then an insignificant positive effect in the long-term. This project element is expected to maintain instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of nutrient and wood routing.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

Existing meadows and wetlands would be protected with the project design features. Releasing beavers at eight sites would increase the amount of wetland habitat in the project area. Proposed projects are expected to maintain the timing, variability, and duration of floodplain inundation and water table elevation in meadows, wetlands and floodplain development.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply *amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.*

Most Riparian Reserves would be untreated; therefore, the overall current condition would mostly be maintained. The limited amount of commercial and non-commercial thinning and/or underburning (in shrub communities) in Riparian Reserves is designed to restore the species composition and structural diversity of riparian plant communities. This includes forbs, grasses, shrubs and trees; snags, “old-growth,” and thickets of young trees; rotten logs and newly-downed wood of various sizes. Thinning competing small-diameter Douglas fir from larger riparian trees may improve the long-term supply of coarse woody debris at a few sites. Decommissioningriparian roads would increase the amount of vegetated riparian area. Therefore, the proposed harvest, prescribed burning, and road management would not retard the area from maintaining or restoring species riparian composition and structural diversity of plants capable of providing the above protection and complexity at the project scale.

9. Maintain and restore habitat to support well distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

Riparian Reserves treatments were chosen carefully to restore habitat and riparian function at those sites. A majority of the Riparian Reserve acres remain untreated and riparian dependent species would be undisturbed over about 90 percent of the total RRs in Buttermilk and 80 percent in the Libby Creek sub-watershed. The commercial and non-commercial thinning and underburning (in shrub communities) are designed to restore the species composition and structural diversity of riparian plant communities. Projects are expected to maintain habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

<u>Summary</u>

The project would reduce the amount of riparian roads by41 to 49 percent and stream crossings by 53 to 58 percent of all stream crossings. Fine sediment levels would increase temporarily for 1-3 years. Design criteria will minimize these effects to negligible levels. In the long-term, this effort will reduce sediment sources across the project area and improve fish habitat conditions downstream. Fish survival and localized production is expected to increase, thereby improving the biological resource condition. All applicable water quality and aquatic standards and guides would be met with the project design features.

Degree to Which the Purpose and Need for Action is Met

The purpose and need for the project includes addressing high road-stream interactions, low base flows, low fish habitat complexity, and artificial fish barriers. These impacts limit water quality, fish habitat quality, and localized fish production for at-risk fish species. The Mission Project would will remove several miles of riparian roads, stream crossings, re-establish beaver colonies, remove fish barriers, and add wood to at key locations to improve hydrologic and aquatic resource values (Figure 36).The primary long-term effect of the project to at-risk fishery habitat would be improved fish habitat conditions. We expect this would slowly improve fish production in the project area that would work with other restoration efforts across the Upper Columbia Basin leading to recovery of ESA listed fish species.

Figure 36: Summary comparison of how the alternatives address the Purpose and Need

Resource Element	Resource Indicator	Measure	Alt 1 (No Action)	Alt 2	Alt 3
Water Quality (Sediment)	Catchment Road Density	Number of Catchment Rankings Lowered	0	5 (3 High to Moderate, 2 Moderate to Low)	8 (5 High to Moderate, 3 Moderate to Low)
	Road Drainage Network Increase		0	5 (2 High to Moderate, 3 Moderate to Low)	10 (2 High to Low, 2 High to Moderate, 6 Moderate to Low)
	Riparian Road Density		0	8 (4 High to Moderate, 4 Moderate to Low)*	11 (2 High to Low, 5 High to Moderate, 4 Moderate to Low)*
	Road-stream Crossing Density		0	6 (1 High to Low, 1 High to Moderate, 4 Moderate to Low)	9 (1 High to Low, 7 High to Moderate, 1 Moderate to Low)
	Ground Cover	Amount of bare soil	0	+105 acres	+105 acres
Water Quantity (Base Flow)	Beaver Habitat	Number of beaver release sites	0	8 sites	8 sites
Aquatic Habitat	Stream Channel Complexity	Miles of stream Restored	0	8.3 miles	8.3 miles
	Fish Distribution	Miles of accessible habitat	0	5.6 miles	5.6 miles
		Number of aquatic passage pipes installed	0	8 AOPs	8 AOPs

Other Agencies and Individuals Consulted

US Fish & Wildlife Service and National Marine Fisheries Service was consulted with for a “may affect, likely to adversely affect” determination for steelhead and bull trout and their critical habitat. The project was consulted on for a “may affect, not likely to adversely affect” spring chinook and their critical habitat.

References

Barrier removal http://www.tandfonline.com/doi/full/10.1577/1548-8675(2002)022%3C0001%3AAROSRT%3E2.0.CO%3B2

Appendix A. Hydrologic/Aquatic Resource Design Criteria and Mitigation Measures.

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
	Commercial Harvest around Ephemeral Draws	No buffer/do not skid up-down low point of draws, minimize/ mitigate crossings	To prevent compaction of ephemeral draws and forcing sub-surface flow to the surface	High	Reduced base flows in fish bearing streams, which reduces fish habitat quality.
		Avoid new landings/ piles directly within low point of draws.			
	Commercial Harvest near Intermittent Streams	*Buffer* 50ft for 0-10% slopes. Winter harvest or no equipment in RR.	To minimize soil disturbance, surface erosion, and stream sedimentation. Protect shade on perennial streams	Moderate-High	High ground disturbance, surface erosion, and stream sedimentation. Reduced shade on perennial streams and increased stream temperature. Collectively, this reduced fish habitat quality.
		Buffer – 70ft for 11-25% slopes. Winter harvest or no equipment in RR.			
		Buffer – 90ft for 26-35% slopes. Winter harvest or no equipment in RR.			
	Commercial Harvest near Perennial Streams, Ponds, Lakes, and Wetlands	Buffer - 100ft. Winter harvest or no equipment in RR.			
	Commercial Harvest Landings in Riparian Reserves	New landings will not be constructed within RRs unless other practicable locations outside the RR (first priority) or existing landings inside the RR (2nd priority) are not available.	To minimize soil disturbance, surface erosion, and stream sedimentation. Protect shade on perennial streams	Moderate-High	High ground disturbance, surface erosion, and stream sedimentation. Collectively, this reduced fish habitat quality.
		The Timber Sale Administrator shall take into consideration that use of existing sites, especially those currently causing resource damage (as identified by project hydrologist, soil scientist, or fish biologist), will allow for immediate mitigation and post-use rehabilitation of landing location and associated roads/skid-trails within the constraints of timber harvest contract administration.			

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		The Timber Sale Administrator shall weigh the relative ground disturbance area considering skid distance, landing size, slope of landing area, slope and vegetated cover condition of riparian buffer strip, and other factors. There may be cases where total number of landings within RRs is not the best metric for reducing impacts via ground disturbance within RRs.			
		Areas where mean site slope exceeds 5% will not be approved for use as landings.			
		Areas where the riparian buffer strip is not well vegetated or is in a disturbed condition will not be approved for use as landings.		Moderate-High	High ground disturbance, surface erosion, and stream sedimentation. Reduced shade on perennial streams and increased stream temperature. Collectively, this reduced fish habitat quality.
		Organic debris will be placed along margins of landings as needed to prevent erosion.			
		If a harvest unit occurs within a RR and utilizes an existing road as its downslope unit boundary, landings below that roadway will not be approved for use as landings.			
		If landings are constructed or re-constructed in RRs, suitable erosion control measures such as silt fences or other retention methods will be installed prior to landing construction and will remain in place during harvest operations. Any landings used within RCHAs will be scarified, seeded, and organic debris will be scattered over them after harvest activities are complete.			
	Commercial Harvest General	Commercial harvest would apply no treatments within inner buffer of RRs. Buffers vary according to RR category/water resource and slope, with details presented in Figure 48.	Protect stream temperatures by avoiding new openings in inner RRs, provide sediment filtration, as well as other resource functions.	High	Increased solar radiation and stream temperatures

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		The Timber Sale Administrator or other authorized personnel shall consider the requirement to place slash in drainage features to provide additional sediment trapping/filtration function. These locations may include natural drainage swales in the unit or below the road, ditch lines where anticipated flows would not put the roadway prism at risk of failure, skid trails, etc.	Filter and trap sediment.	Moderate	Increased soil disturbance and surface erosion
		No more than 20% of any 6th field sub-watershed will be burned in any single year (Beche et al.2005).	Limit cumulative impacts of prescribed fire on RR resources	Moderate	Greater than 20% of a watershed burned can lead to increased fire effects on aquatic and riparian resources.
		For summer harvest units, when necessary to cut benched skid trails within outer RRs (outside of the No Treatment buffer), cut benches will be re-contoured, stabilized, and restored the same operating season.	Avoid destabilizing slopes.	High	Increased soil disturbance and surface erosion
		Perennial stream crossings on summer haul routes will be treated by applying rock to the running surface of road segments with a grade greater than 3% that could potentially deliver sediment at the stream crossing. This treatment would be applied to perennial stream crossings and intermittent stream crossings within 300 feet of a perennial stream. All locations will be subject to field verification by engineering staff with input from aquatic or hydrologic specialists as appropriate. Table A-6 lists of roads that may have rock treatments (field verification will evaluate need for treatment).	Reduce road-related sediment	High	Increased surface erosion

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		Machines can operate in RRs in selectunits under winter conditions, over frozen ground. If outside of winter, equipment would not enter RRs. Exceptions are where the harvest would occur to an existing road and be at least 100 feet from a stream.	Limit Machine use in RRs	High	Increased soil disturbance including compaction, rutting and potential sediment delivery to streams
	Non-commercial thinning	Intermittent Streams: 10-foot no treatment buffer or inner gorge (>35%), whichever is greater, LFR/NCT cutting of understory trees	To maintain understory instream-wood recruitment and shade along perennial streams	High	Reduced wood recruitment and increased stream temperatures
		Perennial Streams: 50-foot buffer LFR/NCT cutting of understory trees.			
	Hazard Fuels Treatments in Ephemeral Draws	Avoid hand piles directly within low point of ephemeral draws, unless no other option is feasible.	To avoid removing ground cover and prevent surface erosion	High	Increases risk of surface flows and sedimentation of streams downslope
		Machine Piling: Minimize crossings, do not use low point of ephemeral draws as travel way for equipment. Perpendicular crossings. Avoid machine piles directly within low point of draws			
	Hazard Fuels Treatments in near Intermittent streams	Ladder Fuels Treatments: No treatment within 10-foot buffer or inner gorge (>35%), whichever is greater, LFR/NCT cutting of understory trees	To maintain understory instream-wood recruitment and shade along perennial	High	Reduced wood recruitment and increased stream temperatures. Increases

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		Machine Piling: Permitted in outer edge of RR in units 022 and 347 in Proposed Action. None other is proposed. Permitted in outer edge of RR in units 019, 064, and 066 in Adaptive Strategy. None other proposed.	streams. To avoid removing ground cover and prevent surface erosion		risk of surface flows and sedimentation of streams
		Underburning: Active lighting within RR up to 25 feet of channel with maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 50% ground cover/organic material on surface. No ignition within 25 feet of stream channels, creeping fire into this zone is acceptable.	To avoid removing ground cover and prevent surface erosion	High	Increases risk of surface flows and sedimentation of streams
	Hazard Fuels Treatments in Perennial Streams and ponds/lakes >1 acre	Ladder Fuels Treatments: Not treatment within 50ft, above inner gorge (>35%), beyond mesic riparian vegetation, whichever is greater.	To maintain understory instream-wood recruitment and shade along perennial streams	High	Reduced wood recruitment and increased stream temperatures
		Machine Piling: Permitted in outer edge of RR in units 022 and 347 in Proposed Action. None other is proposed. Permitted in outer edge of RR in units 019, 064, and 066 in Adaptive Strategy. None other proposed.	To maintain understory instream-wood recruitment and shade along perennial streams. To avoid removing ground cover and prevent surface erosion	High	Reduced wood recruitment and increased stream temperatures. Increased risk of sedimentation of streams
		Underburning: Active lighting within up to 100 feet of channel or wetland with maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 50% ground cover/organic material on surface. No ignition within 100 feet of stream channels, creeping fire into this zone is acceptable.			
		Ponds and Lakes >1acre: Machine Piling is permitted in outer edge of RR in units 022 and 347 in Proposed Action. None other is proposed. Permitted in outer 50' of 150' RR. Not permitted anywhere where mesic riparian vegetation dominates.			

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
	General Fuels Treatments	Fire effects within the riparian areas will be closely monitored and implementation techniques will be utilized. Fire spread into riparian areas is acceptable, however if fire effects becomes unfavorable within the RR's, Minimum Impact Suppression Tactics (MIST) would be utilized to suppress fire spread.	Minimize soil disturbance, canopy removal, and mortality of deciduous species in RRs	Moderate	Increased soil disturbance and potential sediment delivery to streams
		Wetlands will be excluded from burning.	Limit disturbance of burning on wetlands.	High	Noncompliance with NWFP ACS Objectives
		If prescribed burning in RRs are not meeting ACS Objectives, ignition would cease. Ignition may continue if needed to bring the unit to a reasonable safe holding feature, then burning in RRs will cease. Aquatics, hydrology, and/or soils staff would assess effects and determine needs for mitigating measures to reduce erosion and sedimentation potential from the site. Mitigation may include scattering coarse woody debris, spreading weed free hay, installing straw waddles, etc. Application of these measures will be determined according to anticipated resources at risk, burn severity observed, and other factors.	Minimize sediment delivery impacts from prescribed fire in RRs	Moderate	Increased soil disturbance and surface erosion
		Hand fireline will be generally < 2 feet wide; dug to mineral soil depth only.	Limit impacts of fireline in RRs	High	Increased soil disturbance and surface erosion
		No dozer fireline will be constructed within an RR.	Prevent excessive ground disturbance in RRs that leads to surface erosion	High	Increased soil disturbance and surface erosion

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		Hand fireline will not be constructed within an RR except for the purpose of controlling backing fire in a RR, hand fireline may be constructed within approximately 100 feet of a stream if the line is located outside/above a defined inner gorge.	Prevent excessive ground disturbance in RRs that leads to surface erosion	High	Increased soil disturbance and surface erosion
		Fireline will not be constructed parallel to the stream channel within the inner gorge.	Prevent excessive ground disturbance in RRs that leads to surface erosion	High	Increased soil disturbance and surface erosion
		Water may be used to pre-wet riparian vegetation in RRs before burning. Surfactants and foams in water will not be used within 100 feet of the edge of wetted channels, lakes or wetlands. Engines which have had surfactant in their tanks must use an auxiliary pump to fill.	Avoid using surfactants.	High	Chemical contamination of surface water. Sensitive fish mortality
		For all ground-disturbing activities within RRs, maintain > 90% vegetative ground cover provided by trees, shrubs, grasses, sedges and duff.	Minimize production of sediment in areas near streams.	Moderate	Increased soil disturbance and surface erosion

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
	road	Stream crossings will be decommissioned by: dewatering the site or isolating it from flowing waters to prevent delivery of sediment to watercourses in accordance with the WDFW/FS MOU; excavating the fill and restoring slopes and stream channels to mimic the natural stream channel and banks and restore the natural valley configuration; placing and shaping excavated material into cutbanks near the crossing in such a way that sediment-laden runoff can be confined; and/or placing large woody material and/or large rocks as necessary for streambed substrates to mimic the natural streambed characteristics upstream and downstream of the crossing removal.	Ensure road decommissioning at stream crossings provide a natural hydrology.	High	Noncompliance with Washington Department of Fish and Wildlife MOU with the Region 6 Forest Service for projects occurring in waters of the State of Washington
		Under road closure, stream culverts would be removed unless there is very deep fill, it is adequately sized to pass a 100-yr storm event, the channel is stable, and it is not below a recently burned area.	Define the circumstances when a culvert will not be removed for road closures.	High	Maintain artificial sediment delivery sources and catastrophic road failures
		Activities implemented when closing roads (changing to Maintenance Level 1) may include but are not limited to: blading and shaping the road surface to restore proper cross-slope, reinstalling drain dips and installing waterbars, spreading slash or debris over the road surface, and blocking the road with an earthen berm. Road closure work associated with haul routes will be completed prior to winter.	Apply appropriate level of road closure (ML 1) activities.	High	Maintain artificial sediment delivery sources and catastrophic road failures

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		Roads identified for decommissioning will be evaluated by engineering staff and site-specific prescriptions for decommissioning developed with input from other resource specialists will be provided as appropriate. Evaluation will include existing drainage structures, slope stability of fill and cut slopes, signs of erosion, adequacy of vegetation, etc. Where roads are located outside of Riparian Reserves, the road is densely vegetated, or no hydrological concerns exist no active decommissioning may occur. Where active decommissioning would occur, light, medium or heavy road decommissioning practices are applied as described in the Transportation Report.	Evaluate and apply appropriate level of road decommissioning activities.	High	Un-necessarily costly road decommissioning and in adequate road removal in critical areas that will lead to legacy road impacts.
		Temporary stream crossings will be used and obliterated the same season, before the spring runoff period.	Minimize impacts of temporary road-stream crossings	High	Increased soil disturbance and surface erosion
		To minimize detrimental soil disturbance, temporary roads will be constructed to minimal standards necessary for safe use and decommissioned/obliterated following completion of harvest activities. Decommission activities may include decompaction, re-contouring, slashing, and seeding to speed recovery of soil and limit unauthorized OHV use.	Minimize soil impacts from temporary roads.	High	Increased soil disturbance and surface erosion

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		Snow plowing will include water drainage outlets appropriately spaced, constructed and maintained in the dike of snow or berm caused by snow removal operations. Water drain holes will be placed to obtain surface drainage without discharging on erodible fills. Typically, snow removal will be conducted in such a way as to keep the dozer blade a minimum of 2 inches above the road surface.	Ensure proper road drainage occurs after snow plowing.	High	Increased surface erosion
		Design stream culverts to meet 100-year flow capacity. Will follow the WDFW/Region 6 Forest Service MOU Design Criteria for instream work (WDFW & USDA 2012)	Make roads more resilient to failure and minimize impacts to fish and their habitat	High	Roads at high risk of failure that can leade to excessive impacts to fish habitat.
	Water Drafting	Water drafting sites for dust abatement, road compacting or prescribed fire use are located at streams outside of designated critical habitat. Screen mesh openings for all intake screens shall not exceed 3/32 inch (2.38 mm) for woven wire or perforated plate screens, or 0.0689 inch (1.75 mm) for profile wire screens, with a minimum 27% open area. The screened intake will consist of enough surface area to ensure that the velocity through the screen is less than 0.4 feet per second. Screen maintenance will be adequate to prevent injury or entrapment of juvenile fish and the screen will remain in place whenever water is withdrawn from the stream through the pump intake.	Prevent fish taken into water pumps	High	Noncompliance with Washington Department of Fish and Wildlife MOU with the Region 6 Forest Service for projects occurring in waters of the State of Washington

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
		The location, pumping rate, and duration of water withdrawals shall be designed to minimize aquatic impacts. Limit water withdrawals to 10 percent of stream flow or less at the point of withdrawal, based on a visual assessment by a fish biologist or hydrologist or qualified staff. The channel must not be dewatered to the point of isolating fish.	Minimize reductions in stream flow during baseflow	Moderate-High	Reduced habitat quality for fish
	OHV Use	OHVs used for administrative purposes will not leave existing roadways within the RR.	Limit impacts of administrative use of motor vehicles in RRs	High	Increased soil disturbance and potential sediment delivery to streams
	Wetlands	Identify wetlands in units before operations to ensure that activities are consistent with applicable design criteria that implement Riparian Management Objectives.	Ensure activities in wetlands are consistent with ACS OBJECTIVESs.	High	Noncompliance with NWFP ACS Objectives
	Danger Tree Removal	All danger tree mitigation taking place within the RR will be done without off-road use of heavy equipment. Trees will be left on site when needed to meet coarse woody debris objectives. Any yarding will be done in a manner which does not cause soil or riparian vegetation damage, which may include winter conditions (snow/frozen ground).	Avoid soil or riparian damage.	High	Noncompliance with NWFP ACS Objectives

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
	Fuels/Chemicals	For all operations using heavy machinery, equipment, or gas-powered tools, measures will be in place to contain accidental spills of hazardous materials and petroleum products. Any fuels cans for pumps, etc. will be refilled outside of RRs or on a road and pumps will be placed on absorbent cloth to capture any leaks or spills.	Prevent drainage to streams from leaks or spills of hazardous materials and petroleum products.	High	Chemical contamination of surface water. Sensitive fish mortality
		Helicopters will only use existing landings and all refueling sites will be outside RRs	Minimize potential impacts to water quality from fuel spills	High	Chemical contamination of surface water. Sensitive fish mortality
	Coarse Woody Debris Placement	Will follow the WDFW/Region 6 Forest Service MOU Design Criteria for instream work (WDFW & USDA 2012). For example, the project would work within the designated "instream work window" to minimize impacts to fish.	This project would use design criteria described under the Conservation Measures for Fish Passage Culvert and Bridge Projects described in the 2014 FWS and NMFS Washington State Fish Passage and Habitat Enhancement Restoration Programmatic Consultation Biological Opinions (FWS No.: 13410-2008-FWS # F-0209 & NMFS Tracking No.: 2008/03598).	In order to comply with applicable ESA and Clean Water Act laws, this project would follow a suite of design criteria aimed at minimizing impacts to aquatic and riparian resources.	These design criteria have been used for a decade and have proven to be effective in minimizing project effects to fish species and their habitat. See this document for detailed descriptions for all criteria.
	Aquatic Organism Passage	Will follow the WDFW/Region 6 Forest Service MOU Design Criteria for instream work (WDFW & USDA 2012)	This project would use design criteria described under the Conservation Measures for Fish Passage Culvert and Bridge Projects described in the 2014 FWS and NMFS	In order to comply with applicable ESA and Clean Water Act laws, this project would	These design criteria have been used for a decade and have proven to be effective in minimizing project effects to fish species and their habitat. See this document for detailed descriptions for

Number	Activity	Design Feature	Why Necessary	Efficacy	Consequence of Not Applying
			Washington State Fish Passage and Habitat Enhancement Restoration Programmatic Consultation Biological Opinions (FWS No.: 13410-2008-FWS # F-0209 & NMFS Tracking No.: 2008/03598).	follow a suite of design criteria aimed at minimizing impacts to aquatic and riparian resources.	all criteria.

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